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Race, Nations, Class: Lessons of Genetics

WHAT is a race? We all have some rough idea what we mean by the term; we are all too familiar with it as a persecution cry. For this is a scientific age, and to make even persecution plausible one has to give it a pseudo-scientific justification. But, apart from persecution, what does race really mean?

It is not at all an easy question; but it is answered, provisionally but with great clarity and judgement, in Dr Waddington's new book, *An Introduction to Modern Genetics.** This book will be reviewed by a specialist in a later number of *Discovery*, for it is intended mainly for biological students and not for the general public. But it would be a pity if some of Dr Waddington's conclusions were not more widely read, because they bear on problems of pressing human importance, and have been reached by a mind which is at once creative and informed, non-partisan and humane.

Incidentally, the book is written with admirable lucidity, and many of the pages on human genetics are not too technical to be quoted here.

RACE

Man is a very variable animal. An Australian aborigine, a Chinaman and a West European differ as much from each other as do many related species of monkeys. But all the living types of man are mutually fertile, and it is usual to classify them all in a single species, *Homo sapiens*. In man we are interested in so many characters that we can hardly ever find two individuals which do not differ in some respects; we can never deal with

* Geo. Allen and Unwin. 18*s.*

groups which are uniform for all the characters we examine. The only hope of applying a race concept is to limit the sphere of reference, and to do that we shall only take account of certain sorts of characters.

If we limit the number of characters severely enough, we can distinguish a few large groups of mankind, such that the different groups are pretty sharply distinguished from one another and we do not find many intermediates except obvious hybrids. Thus we can discriminate the "races" of whites, negroes, American Indians, yellows, Australians, etc. But these groups are themselves not all uniform. When we try to...discriminate minor races within the great groups of whites, blacks, etc., we find that it is extremely difficult to draw any dividing lines within the general chaos of variations.

We can set about the attempt in two ways. In the first place, we may define a set of characters which we take to be characteristic of a certain race. For instance, we might say that the Nordic race has long heads, blond hair and blue eyes. But this only has any sense if we believe that a group of men having these characteristics exists now or existed at one time. In the absence of any detailed knowledge about the past, the justification for such a definition reduces to whether or not we can find such a group at present. We must therefore tackle the problem in the second way, which is to examine human populations and see how they can be grouped. If we do this, we can in fact find groups which are homogeneous in the sense that, although they show variation, this variation is continuous and the group cannot be split up into smaller groups which are significantly different from one another. But these homogeneous groups are extremely small and insignificant. They are usually isolated communities living under fairly primitive conditions and have a high degree of inbreeding. We might attach a definite meaning to the term race if we defined it with reference to such groups, but the concept would not be very useful. We should in the first place have to make sure that the characters concerned were hereditarily and not environmentally determined. This is not always certain; it is probable that even the cranial index, that sheet-anchor of the physical anthropologist, can be modified by the environment, since it is less extreme in the American-born children of immigrants than it was in their parents. Even when this point had been disposed of the races would only be definitely characterized in respect of the points mentioned in their definition; there is no reason to suppose that because a population is homogeneous for long-headedness it is therefore homogeneous for other characters such as intelligence. Finally, such a concept of race could not be applied to individuals. In the first place, different races overlap, so that the longest-headed members of a short-headed group have longer heads than the shortest variants of a long-headed group. Even if we knew an individual belonged to one of the pure races, we could not tell, looking at him alone, which of the races it was. And, further, as we have said, only a few small populations do consist of pure races. The vast majority of the population is made up of individuals who would have to be considered as very complex hybrids showing all sorts of segregation and recombination.

Thus the attempt to classify mankind into genetically homogeneous groups becomes progressively more difficult as we take account of more genes. If we try to derive a concept of race which will be relevant to all characters of a man, the attempt is a complete failure.

Nations and Races

The concept of nationality has, in recent years, often been confused with that of race. It should be unnecessary to state that nationality is not a genetical concept at all. It can be defined either in political terms, as all the people living under a certain government, or in cultural terms, as all the people enjoying a certain cultural tradition. Neither of

these entities has anything to do with the concept of race, even on the loosest definition of that troublesome word. The habit of referring to alleged national characteristics, such as "British hypocrisy" or sense of "cricket", as though they were racially determined, is also clearly unjustified. Not only are nations not necessarily races, but we know very little about the mental differences which presumably exist between different racial groups.

A few attempts have been made to investigate such differences and evaluate them in genetical terms. American negroes, for instance, nearly always give lower average I.Q. scores than whites, from whom they differ "racially" as well as culturally. Typically the average negro I.Q. is about 75–80% of that of the whites. But there is considerable overlap when individuals are considered, and about 25% of negroes equal or surpass the white average. The genetic significance of the results is very difficult to assess. Unfavourable environment certainly plays some part in lowering the negro attainment; thus negroes from northern states score better than those from the poorer southern states, and when the negroes and whites live under approximately the same conditions, as in the small island near Jamaica investigated by Davenport and Steggerda, their average scores are more nearly the same (but in the former case there may have been some selection of better negroes in the northern states and in the latter of poorer whites to live on the island). Tests on negro infants of 2–11 months, on whom the external environment has not had much time to act, show that they also score slightly lower than white infants in the so-called Baby Tests, but the difference is not so large as when adults are compared. Even at this age, the negro children are somewhat inferior to the whites in physical development, so that it is probable that their environment, including pre-natal environment, had been inferior. There is as yet no way of telling whether these environmental effects can account for the whole difference between whites and negroes; it is perhaps rather unlikely that they can. It must be remembered, however, that the I.Q. tests do not measure all aspects of personality, and there may be other respects in which negroes surpass whites.

Class

Men are not only divided into racial and national groups, but, in all civilizations except some of the most primitive and the most advanced, they are also stratified into classes. In societies founded on the labour of slaves captured in war, we should expect to find considerable genetic differences between the ruler and the ruled. But few such societies now exist. In this section we shall discuss the genetic differences between classes in present-day capitalist civilizations.

If mental tests (I.Q. tests, performance tests, etc.) are made on individuals belonging to different classes, it is commonly found that the average score for professional men is higher than for shopkeepers, for those again higher than for skilled workers, and for unskilled workers lowest of all. There is of course an enormous overlap; and since the lower categories are much more numerous than the higher, the greatest number of individuals above normal may come from one of the intermediate groups such as the skilled workers. Even the average differences, though statistically significant, are not large, the limits of the range being about 15–30% in different investigations.

Before any genetical significance can be attached to these results, we must discuss how large a part environmental agencies play in producing them. Unfortunately this question is nearly always confused by political considerations. The Left usually wish to show that the differences are entirely accounted for by the educational disadvantages under which the poorer classes suffer, while the Right wish to regard them as solely

genetic. It is difficult to see any necessity for these attitudes. If there is any injustice in the present distribution of the physical or mental amenities of life, that injustice is not increased by showing that the servant is as good as his master, nor lessened by demonstrating that we are only kicking the weaker brethren. If these considerations are borne in mind, it should be possible to approach the question with no preconceived bias, and to obtain an objective scientific judgement on it.

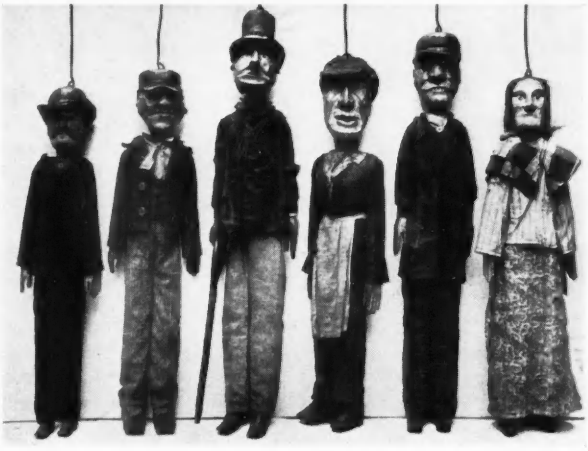
It is extremely doubtful, however, if we yet have adequate data to make a final decision as to the relative importance of heredity and environment in producing class differences. The study of twins and of exceptional families makes it likely that hereditary differences such as occur in the population can easily produce effects of the right order of magnitude. But so, clearly, can the environment, whose most profound effects are seen in studies of "wild boys" who have been abandoned far from the haunts of man and grown up entirely on their own resources. James the Fourth of Scotland is said to have performed the experiment of isolating a young child on an island in the Firth of Forth; when visited some years later he was able to speak good Hebrew. Most parts of the world are less like the Garden of Eden; the wild boys do not develop any mode of speech and their intellectual development is very meagre indeed.

But the environmental disadvantages of the lower classes are certainly not of this order. We get rather nearer to them in investigations on children who have been prevented by physical illnesses from attending school for the full period; their intelligence test scores are adversely affected more or less in direct ratio to the length of time they have lost. Again, children of bargees and gipsies only attend school very irregularly, and while the I.Q. of the youngest tested (four to six years) is only slightly below average (90 instead of 100) the average gradually falls with age and for the group between twelve and twenty-two years is only about 60% of the normal. We have already mentioned the fact that the scores of different American conscripts was correlated with the expenditure of their state on education. Finally, the differences between the averages for the highest and lowest classes (15–30%) is not much more than twice the average differences between identical twins (10%) which have been produced by the very slight differences acting on two individuals of the same sex and birth rank in the same family.

We can certainly conclude from this that the genetic differences between the classes are considerably less than their average performances would suggest. But they may not be negligible. Particularly the lowest class of unskilled labourers, who very rarely produce any individuals above the average, may really be genetically slightly inferior.

Those are the calm judgements of one of the comparatively few men in the world whose opinion is worth much on these matters. They are tentative, they are not spectacular. They are scientific. It is more than ever important, among this din of raving nonsense, that they should be heard.

THE EDITOR



Folklore in Wallonie

By Winifred Holmes

Wallonie and Flanders have existed side by side for centuries—sometimes united, sometimes facing each other in hostility. The revolution of 1830, by which Flanders parted from her Calvinistic kin, the Dutch, united her to the Walloons, nearer to the French in culture and race, and made the independent kingdom of Belgium possible. Now, after a century of Walloon ascendancy, of French as the official language, and of a disfranchisement and despisal of the Flemish as a political and cultural group, there is again intense hostility between them, and Belgium is rent in two by a racial question which will probably end before long in political division and autonomy for both groups on the Swiss plan. Then each state-within-a-state will be free to make affiliation of trade and culture with her neighbour—the Flemish with the Netherlands and the Walloons with France.

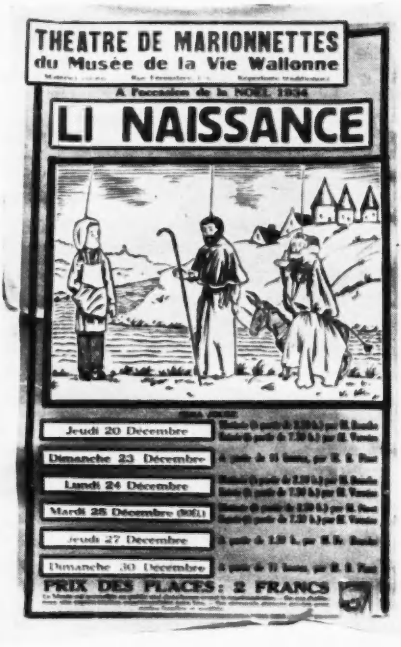
It therefore seems an apposite moment to consider the Walloons as a people, and to delve into their origins, culture and folklore. Numerically there are at present one million fewer Walloons than Flemish, and they have a lower birth-rate. The Belgian provinces of Hainaut, Namur and Liége are Walloon as well as parts of Luxembourg and south Brabant and villages in Malmédy. In France, several districts of Nord and Ardennes are also inhabited by Walloons. A recent visit to Belgium has given me the opportunity of studying them as a people at first hand, and I am much indebted to M. Albert Marinus, Belgium's eminent folklorist, and to the Director and Curator of the delightful Musée de la Vie Wallonne, Liége, for the valuable help they so kindly gave me in this research.

The name Walloon is derived from a Teutonic term meaning foreign, from which also comes the word Welsh. The Walloons were certainly foreigners to their Teutonic neighbours, the Flemish and Germans, as they are of Gallic-Belgae stock mixed with Roman and are akin to the French racially, though forming a separate branch of the Romance family. The Romans came conquering and colonizing across Europe and left their mark on Wallonie—roads, spas,

people—and, leaving out the Low Countries proper, turned north-eastward into Germany via Cologne.

In comparison with the Flemish the Walloons are lighter built and darker eyed, more volatile, adaptable and quicker in movement and thought. At the same time they are more industrious and enduring than the French. Musical rather than pictorially artistic, they are immensely fond of dancing and athletics. Every village in the Ardennes has its Sunday open-air dancing and games, followed by a feast. Religion is to them a less serious matter than it is to the Flemish, and none of their processions or mysteries has the grim realism of, for instance, the Procession of the Holy Blood at Bruges.

Instead of the works of a Breughel or van Eyck they have produced charming little "Noëls", echoes of twelfth-century hymns; "pasquêyes", popular political songs; satires in the vein of Gay and Congreve; and a lively marionette theatre of ancient origin based more on the Romance legends of the *Bibliothèque Bleu*, with Charlemagne and the four sons of Duke Aymon as chief characters, than on the Bible stories—although *Li Naissance*, with Mary in a Spanish mantilla, is a popular number of the repertory at Christmas time. There are old and distinctive marionettes in Flanders too, but as the Walloons are a Romance people and looked to France for their lead, it is most probable that the tradition spread upwards from the south. Certainly their marionettes are different from the Flemish ones, and have a different racial stamp, although both Flemish and Walloon puppets are worked in the same way as Italian and Provençal ones, with a single iron spike through the head.



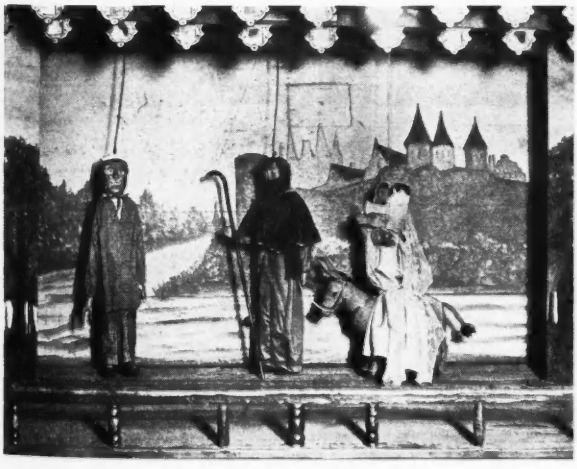
French is spoken by the "haut personnages" of the Walloon theatre, only the clown *Tchantches* (François)—who compères the show and keeps the audience on their toes with mirth at his roistering ways and his topical remarks of good sense, but not always in the best of taste, speaks Walloon. His wife, prudent and disapproving, is Nanesse, and both caricature some local worthy or comic character known to the marionette-maker. A glance at a row of *Tchantches*, as in the picture on p. 275, and on the cover, collected by the Musée de la Vie Wallonne, Liége, shows us how well some drunken cobbler, skinflint farmer, or pithy cheap-jack saw himself guyed for the neighbourhood's amusement.

In the flight into Egypt scene in *Li Naissance*, *Tchantches* appears as a countryman in sabots, check trousers and smock, with a rubicund stupid face and tightly-pressed button mouth. The faces of Joseph and Mary are insipid and characterless in comparison. So too are the faces of the three giant Magi, in an earlier scene, for all their dark skins, beards, flowing moustaches and staring eyes. *Tchantches* this time appears in a huge stove-pipe hat with a drunkard's pippin-red cheeks and nose. This marionette theatre is essentially a

folk-art, and there seems no incongruity or blasphemy in a clown—symbol of the common people—accompanying even the most reverent of religious scenes and mysteries.

The Museum of Liége is keeping the tradition alive and gives performances during the winter in its little theatre, attended by about forty people each time. In Brussels, the fourth in succession of a line of marionette-makers, Toone IV, still gives performances in the little Impasse de Varsovie off the city's Whitechapel Road, three times a week to crowded audiences of workmen in cloth caps and mufflers, but his marionettes are more Flemish than Walloon in character, and incorporate some of the cloak and sword romances of Henri Conscience, the Walter Scott of Flanders.

As in Flanders, each important district of Wallonie has its annual procession and carnival, but most of these have a secular and chivalric rather than a deeply religious flavour. St George and the Dragon are favourite characters and have their apotheosis in the famous *Lumeçon of Mons*, a pageant held in the *Grand Place* every Trinity Sunday. First recorded in 1380, there is no reference to the dragon, or the *dou-dou* as he is called here, until 1524. Travellers' tales of such exotic monsters filtered into Europe from the East in the fifteenth and sixteenth centuries, and their origin was probably Chinese. At Mons, the *dou-dou* is a strange creature of no known shape, attended by men in white. Joining in the combat (*Lumeçon* means combat or struggle and is a Tarascon word) are men of the woods dressed in leaves, and curious characters named *Tchinchins*, whose mounts are dogs and who wear tartan dresses. St George is resplendent in a cuirassier's helmet and carries a lance of great length.



Local tradition has it that St George is really Gilles de Chin, a knight of Wasmes, who killed a dragon ravaging the district, aided by the Virgin, and was given the hand of the Princess in return in the good old fairy

These grim figures of "death", and devils, are characteristic of the work of Flemish puppet-makers, who are far more serious and realistic than the Walloons

story manner. An old manuscript states that Gilles was Chamberlain to Baudouin IV, Comte of Hainaut. And in the Folklore Museum of Mons there is a monster's head on view—"fie on those who say it is the head of a crocodile brought back by a Crusader!" writes M. Marinus.

The tomb of an armoured knight in the church at Wasmes is thus inscribed: "Cy gist Messire Gilles de Chin Chambellain de Hainaut...qui tua un dragon qui Faisait grand degast au terroir de Wasmes." The inscribed date is 1137.

There is a very beautiful procession connected with a Gilles. But it is Gilles de Binche. The costumes of the performers are copied from what the Spanish soldiers of the occupation took to be Inca ritual dress. They are very beautiful—all white, with waving, towering head-dresses of snowy ostrich feathers and long ribbon streamers. But for strangeness and folk interest it cannot compare with the giant's procession at Ath in Hainaut every fourth Sunday in August. Giants also appear in Flemish processions, but the earliest reference to them is in a Walloon MS. of the fifteenth century. Namur has its processional giants too; a domesticated Goliath with his wife and three children join in the Notre Dame procession of 2 July. But at Ath there is a whole gigantic hierarchy. The Duchess of Ath is carnival Queen; dressed in white, with a veil over her face and a wreath of roses on her head, she comes, with her train of gigantic attendants, to marry her fiancé Goliath. Goliath is armed with a halberd, shield and buckler. Samson comes on to be challenged and slain by David. There appear also the heroic horse Bayard and a figure amusingly like Britannia called *M'selle Victoire*. The giant figures are ingeniously made of wickerwork frames covered with clothes, and inside each walks a man who can peer out of a peephole in the dummy's middle. Behind the giants walk the burgomaster and town councillors, considerably dwarfed in importance! These giants are right in the southern tradition of Spain and Gascony, and it is quite natural therefore that they should have taken such flourishing root in the Romance soil of Wallonie.

So much for outside influences and

Romance affinities. Of indigenous growth are the holy places and shrines, the superstitions and the vestiges of paganism to be traced in the country districts, especially of the rocky wooded Ardennes, where the peasantry has remained ethnographically unchanged by modern civilization. Haunted chateaux, *pas des morts*, *trous des nutons* (dwarfs and gnomes) are to be found everywhere.

The *nutons* of the Walloons are like German gnomes in that they are familiar house-sprites who help by repairing shoes or mending torn coats provided they are given food for payment. If this is not put out for them they take offence and bring bad luck to the family. They especially relish a "broad thin cake dipped in vinegar, and white bread".

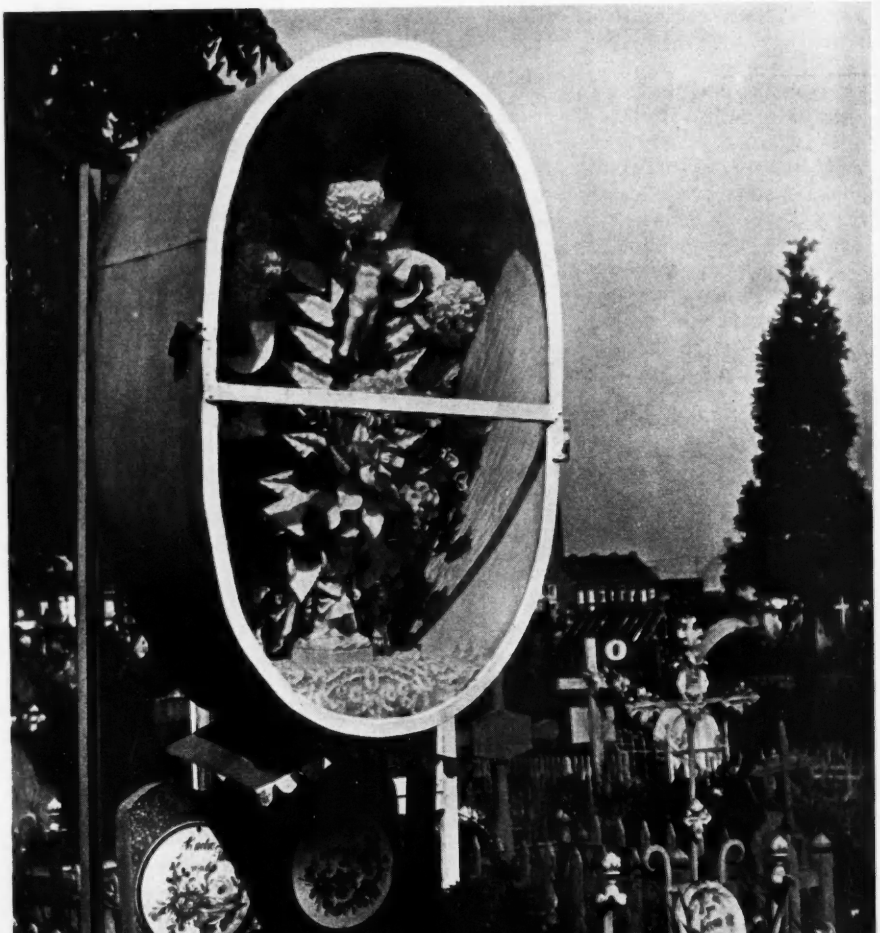
Marionettes made and used in the Toone Theatre, Brussels

Pilgrimages to shrines to be cured of ailments take place regularly and often. Some are purely Catholic in inspiration, but others show distinct traces of paganism. For instance, pious pilgrims come each year on 3 May, from all surrounding districts and from Namur to the Hermitage of St Thibaut hoping for a miracle and to be cured of the *mal de St Thibaut*, which is eating and drinking too much. All of them visit at the same time a sacred waterfall nearby shaded by a tree of especial merit. The peasants cut two branches of it and make a cross out of them which is either nailed to the tree or thrown into the spring. The hermit was supposed to ring a bell when storms threatened so that the peasants could save their harvest. Surely this is based on a peasant rite of great antiquity!

In the Museum at Liége there is a tree-trunk from near Silly studded with nails like a fetich of the Congo, and among the beautiful, ingenious and garish ex-votos, in which local craftsmen take a great pride, there are charms to be worn by women who hope to be helped in their accouchement, and iron crowns to be placed on the altar of St Maur to be blessed so that they may then cure headaches.

Many springs in country districts have magical properties for curing, and at the spring near Sauvenière, an ancient fertility rite can be traced. Married women, desiring children, go there to place their foot in the stone imprint of St Remacle who fell asleep by its waters.

But in the caves of Mt Avertin there still takes place a festival which is paganism



An important aspect of the folk expression of the Walloons is their elaborate and often exceedingly artistic offerings or decorative groups and figures and artificial flowers to commemorate a relative

undisguised. Dedicated to Hercules, it celebrates his slaying of Cacus, Vulcan's cruel son, who collects the bloody heads of men, so freeing them from his horrible ravages.

In a country so fought over and for centuries unsettled as Wallonie, it is inevitable that much of her people's indigenous customs, art, songs and dances have been lost. But the growing interest in folklore in Belgium, which has led to the installation of Museums of Folklore in each district and important town, should not only do a great deal to collect data and preserve material, but to discover and document much of great and valuable interest about this ancient, and to the rest of the world, comparatively little-known people.

Discovering History

By Sir Flinders Petrie, F.R.S., F.B.A.

The general idea of history, to most people, would be a book, or perhaps an Act of Parliament, or an inscription, or possibly hieroglyphics. All that only concerns the last few centuries, or at most the last few thousand years of Man.

What we still need to recover is the last 10,000 years of man's handiwork, and the last 100,000 years of man's bodily structure, and we have but made a beginning in this direction.

The discovery of such history is a matter of picking up thousands of facts, linking them together, looking for the missing connexions, and framing a united view. This truffle hunting is an Art, a personal instinct which must be trained, to imagine what are the likely sources. The various ways in which all this is recovered constitute the Art of Discovery.

Here, as an example, we will trace how the various links of the History of Egypt have been recovered, from the ages before Alexander brought Egypt into European history, and how we discover 7000 years of continuity before his time.

In 1884 an Arab in Cairo showed me an alabaster figure, which I saw was that of an early Greek warrior. I bought it and then asked where it came from; until a thing is secured and paid for, a fictitious origin may be invented to increase the value. I was told Nebireh, and that was near Damanhur. So I went to Damanhur and began enquiry. After tramping for several hours, I reached a low mound with the heart of it dug out for the field dressing. There I walked over smashed Greek vases and charming painted fragments, but had to leave them, till I could undertake the site. So soon as excavation at Tanis was finished, I returned to my Tell, and found an empty house where I could get rooms. At the door lay a horsing block of black stone. I turned it round and there saw a decree of the people of Naukratis, the first home of the Greeks in Egypt, long sought for and now safely identified. That gave us much of the seventh and sixth centuries B.C. in ruins of the temples of Apollo, Aphrodite and other gods.

When I was at Tanis, men pointed out a

distant speck on the horizon seventeen miles away, saying it was Tell Defneh. Having worked Naukratis for a season, 1884–5, I left it in the safe hands of Ernest Gardner, and went there for the season 1885–6, for I guessed that Defneh was no less than Daphnae, the other Greek settlement. At the best site on the way there, I settled and recruited workers, and after some weeks of drilling them in digging a ruined city, I said that I was going into the open desert to Tell Defneh, and asked for volunteers. Off we went, a merry party of forty men, girls and boys, and tramped to our Tell.

A large mound of ruined walls stood there, and we had Daphnae, the Tahpanhes of Jeremiah. Asking the name of it from an Arab, he replied: "The mound of the Jew's daughter." It is named in memory of the flight of the Jewish royal family to that fortress. In front of the entrance was the wide platform of brick, named in the book of Jeremiah, "before the entry of Pharaoh's house in Tahpanhes". The royal sealings of wine jars showed it to be Pharaoh's house. It proved rich in painted vases left by the Greek garrison, and gave another fixed point in the history.

The next link to Europe was in 1889, when I first saw Mykenaean pottery at the mouth of the Fayum province, and found more of it dated by burials to 1300 and 1400 B.C. Further, in 1890 I found a workmen's town with painted Aegaean pottery dated to 2470 B.C., the twelfth dynasty. This was disbelieved until the similar decorated pottery was found in Kamares in Crete, long before the Mykenaean. Some clearance in 1890 also, at the Pyramid of Meydum, brought to light inscriptions dating it to the third dynasty, 3700 B.C., the oldest building yet dated in Egypt.

The arrival of the dynastic people in Egypt seemed from various data to have been at Koptos by way of the Red Sea. So I went there in 1894 to look for evidence. We found names of thirty-six kings of Egypt, from 3700 B.C. to A.D. 260. Long before those, buried in foundations, there were large blocks of rude statues, which were evidently far older than any statues yet known. Later research has placed these as before the dynastic race, at about 5000 B.C.

From there, distant cliffs on the other side of the Nile attracted me, and we went over to look at the place. Some native had turned up a strange kind of pottery in digging. We found that we had at Naqada a prehistoric cemetery with thousands of graves which we can now date to a period 6500–4800 B.C.

At last I was permitted to go to Abydos, and quickly cleared what was left of the Royal Tombs of the first dynasty, 4300–4100 B.C. Here was dated a large amount of vases of fine polished stone, and from the fragments of them more than five hundred forms were drawn. We also secured the four beautiful bracelets of gold and amethyst on the arm of a queen, which ancient plunderers had hidden in a hole. By always giving the finder the metal value of any gold, there is no gain by concealment. Make your workmen co-operate with you as friends, lead them not into temptation.

The stretch of prehistoric times which had been brought to light at Naqada we could now divide into three separate periods; these are named from the places where best exposed, as Amratian, 6300–5500 B.C., Gerzean, 5500–4800 B.C., and Semainean, 4800–4326 B.C., the establishment of the first dynasty.

So far, this register of the prehistoric remained without any more remote basis; but by 1924 some new and strange pottery, found beneath the Amratian in Upper Egypt, at Badari, proved to belong to an earlier age as yet unsuspected. A fresh period, the Badarian, had to be recognized at about 7000 B.C. The pottery is of the most skilful handwork yet known, for its perfect evenness of form and its thinness. Three different types of female figures show a diversity of peoples at that age.

By 1928 it became evident that yet another civilization underlay the Badarian, and this was called the Tasian, from a place near by.

The pottery was of forms not found in later ages, and the skulls were larger and finer than the Badarian.

Now we may sum up, and realize that discovery in the field is as often gained from following up unexpected clues, as it is from searching places of known historic value.

Such is history at first hand, gleaned from the actual works of the ancient people themselves. It is the Discovery of Man.

I have, in this short sketch, only instanced a few of the more striking examples of finding new history, which I have picked out from half a century of researches in the desert. Yet all this is not the half of what I know I could find, had I not been blocked from the places which I see to be most important. The hindrances to historic discovery are politics, and again politics.

The Raw Materials of Evolution

By Dr C. H. WADDINGTON

BIOLOGY has always been in the peculiar position that its most central and fundamental hypothesis, the Darwinian theory of evolution, was not primarily based on experimental work. This is not true of either chemistry or physics. The basic theories of these sciences, such as the atomic theory of chemical compounds, or the electron theory of atoms, were arrived at as a result of experimentation. The theories could therefore be further developed by the application of the same kind of experimental approach, whereas the biologist had no obvious method for the further analysis of the process of evolution and had to fall back on the accumulation of more and more simple descriptive facts about nature, which added very little to those which had first rendered the evolution theory plausible. It is probably this lack of any straightforward and well-recognized method of analysis which is responsible for the extremely slow growth of our knowledge and understanding of the evolutionary process. The great advances of biology in the last half-century have been mainly in other fields, particularly in the investigation of chemical and physical processes which occur in living things.

If we examine the matter more closely, we find that the student of evolution was confronted with two main difficulties. First, he had to find out what processes actually happen in Nature. Is there a natural selection of the fit? If so, how is fitness measured? And how fast does the selection occur? How is it modified by different breeding habits, etc.? It should be possible to answer such questions by careful observation of what occurs in life outdoors. But here the second set of problems arises. Evolution is not concerned with all the characters of an animal, but only with those that are hereditary. If a naturalist observes a group of animals and discovers that the individuals differ from one another in fitness to survive and leave offspring, he still cannot say how important this may be for evolution until he has found out how much of the variation is hereditary and thus handed on to later generations. It is with the recent progress in solving the second problem that this article is to deal.

Quite recently genetics has reached a point of technical efficiency which makes it possible to consider making a genetic analysis of the hereditary variability of a wild population. Even now there is only one group of organisms, the fruit flies of

the genus *Drosophila*, for which such an analysis has been undertaken. In *Drosophila* there are two technical methods, which, taken together, make it possible to analyse the variation fairly completely.

bands correspond in some way to the genes, though it is not yet certain whether each band contains only a single gene or a small group of them. But if the order of the genes in the chromosomes is changed, the

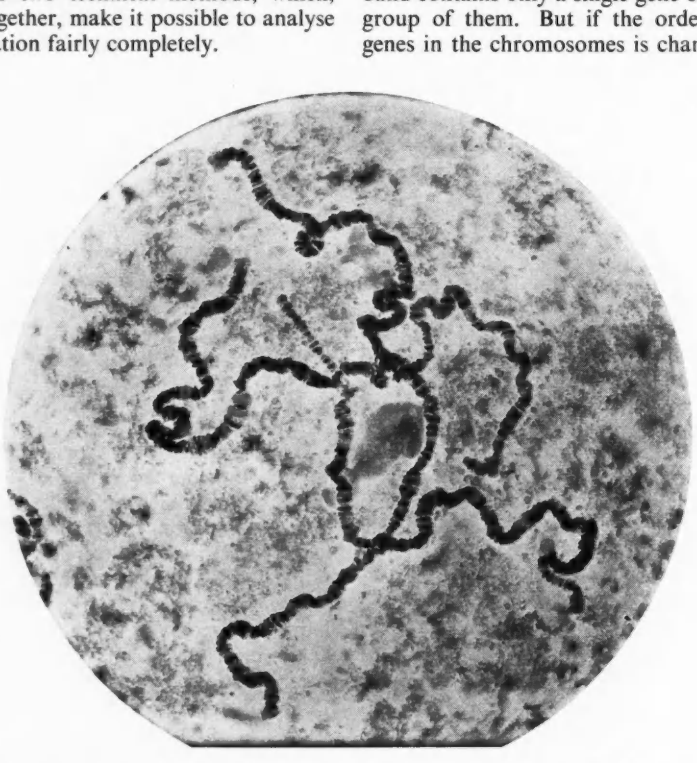


Figure 1. *Chromosomes from the salivary gland cells of* Drosophila melanogaster. *Each ribbon consists of two homologous chromosomes lying closely side by side. The transverse bands correspond with the positions of the genes*

In the first place, there is the so-called salivary gland method for detecting alterations in the sequence of genes in the chromosomes. This depends on the fact that in the salivary glands of Diptera the chromosomes are extremely long and consist of bundles of parallel threads which show a structure of transverse bars and lines. Each of the bundles is really double, since the two homologous chromosomes which are found in all somatic cells are here lying closely side by side, with their transverse bands exactly apposed. The order of bands is changed correspondingly. In a hybrid in which the genes in the two homologous chromosomes are differently arranged, there will obviously have to be some bending around and looping to bring the similar genes together. Thus the formation of loops in the salivary glands of a hybrid betrays the fact that the genes of the two parents were not arranged in the same order. In practice a laboratory stock of flies is kept all of which have their genes arranged in the standard order. Then individuals collected from wild populations can

be crossed with the standard stock, and the number and kind of rearrangements determined by examining the salivary glands in the hybrid larvae.

The surprising result of this work has been to show that gene rearrangements are quite common in Nature. They are nearly all of a particular kind known as inversions, in which the genes *abcdefghij* become rearranged with a section such as *cdefgh* in the wrong order, to make *abhgfedcij*. This can easily be recognized because in the hybrid the section of chromosome corresponding to the standard *cdefgh* and the inverted *hgfedc* stick out from the rest of the chromosome and form a loop, as is shown in Fig. 2.

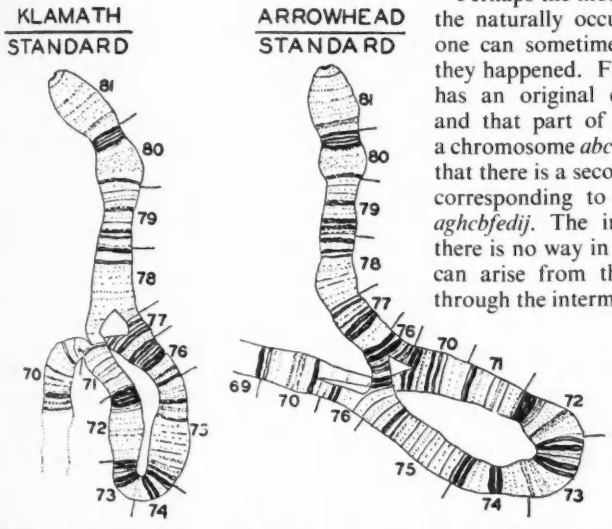


Figure 2. Inversion loops in the salivary glands of hybrid Drosophila pseudo-obscura. *In both cases one of the two chromosomes has the Standard sequence, in which the lines are numbered consecutively. In the Klamath race the section between* 71 *and* 78 *is inverted. In the Arrowhead inversion the inverted section extends from* 70 *to* 76*; notice this order can easily be seen by following round the right side, where we have* 69, *part* 70, *part* 76, 75, 74, 73, 72, 71, *rest* 70, *rest* 76, 77, 78 *etc.*

(*After Dobzhansky and Sturtevant*)

It is not quite clear what part these inversions play in evolution, or what influence they have on the fitness of the flies which carry them. But they certainly do come into the story of evolution somewhere, because if one compares the chromosomes of different species of *Drosophila*, one usually finds that during the evolutionary divergence of the species the gene order has been considerably rearranged by inversions. Some pairs of species also differ in rearrangements of another type, known as translocations, in which a piece is broken off one chromosome and attached to another different chromosome. It is remarkable that no two flies belonging to the same species, and differing in a translocation, have been found in Nature; presumably they will turn up sometime, but they must be very rare.

Perhaps the most interesting thing about the naturally occurring inversions is that one can sometimes decide in what order they happened. For instance, suppose one has an original chromosome *abcdefghij*, and that part of this is inverted to give a chromosome *abchgfedij*; and now suppose that there is a second inversion of the piece corresponding to *bchg*. This would give *aghcbfedij*. The interesting point is that there is no way in which this last sequence can arise from the standard one except through the intermediate step of *abchgfedij*, as we had it above. If one has a large number of overlapping inversions of this kind, there may be only one way in which they can be arranged so as to be derived from one another by single steps of inversion. This is the case with a whole series of inversions in *Drosophila pseudo-obscura*, which tend to occur in different parts of the country which *pseudo-obscura* inhabits, although they occur together in some districts. But this argument enables us to put them in order and determine which

was derived from which with at least as much certainty as if they were fossils lying in rock strata one above the other.

We have so far spoken only of the variation due to rearrangements of the genes, but animals also differ in the actual genes which they contain, and these differences are perhaps more important than mere changes in gene order. Again, this variation can only be investigated by special methods. Each kind of gene in an animal is represented twice, once on each of the two homologous chromosomes (except for genes on the single sex chromosome of a male). Usually, if one of these two genes is replaced by an abnormal "mutant" form, the appearance of the animal is unchanged since the normal gene is sufficient to allow the usual type of development to occur. The abnormal genes are in fact hidden by their normal partners, and in order to discover them it is necessary to breed the flies in such a way that some of the offspring have both their homologous chromosomes derived from the one original chromosome under investigation. The method for doing this is shown schematically in Fig. 3. It will be noticed that here again we come across inversions. But here they are used for a definite technical reason. In a hybrid, the two homologous chromosomes normally break up and exchange parts with one another by the process known as crossing-over; this usually leads to no difficulty, but here we wish to keep the chromosome we are investigating quite intact, so that we can test the whole of it. This can be done by ensuring that the hybrids always contain one normal and one inverted chromosome, since then if any exchange of parts does occur, the resulting chromosomes will be found to be incapable of living; inversions, in fact, act as cross-over suppressors.

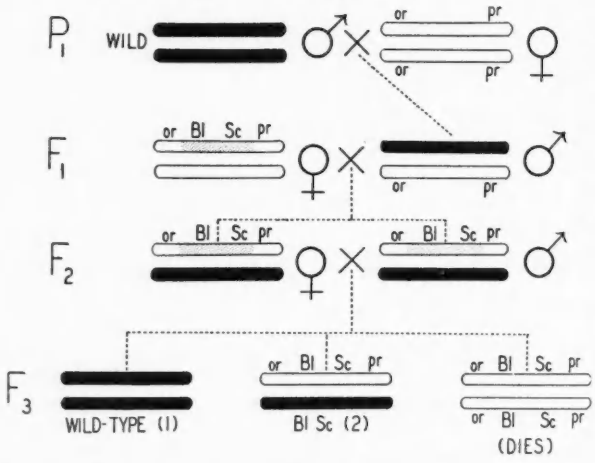


Figure 3. The method of detecting hidden genes in wild flies. The chromosomes of the wild fly are indicated in black. The fly is first crossed with a female containing the recessive factors orange and purple (both eye colours). One son is then crossed to a female of the constitution shown (Bl is a wing character, Sc a bristle character, both dominants; the shaded region is inverted; see text). The offspring from this cross which carry the wild chromosome will not show orange or purple, while the others will. Therefore the non-orange, non-purple flies, when crossed with each other, will give some flies with two of the wild chromosomes. The homozygous Bl flies die (lower right) (*After Dobzhansky and Queal*)

Again, when this method is applied to flies collected in Nature, the extraordinary thing is the large amount of variation in genes which is found. Nearly every chromosome tested contains at least one abnormal gene. The commonest type of mutant gene is one causing a slight lowering in viability and fitness; and only slightly more rare are lethal genes, which make it impossible for the animal to survive at all. Both these types of genes will obviously be eliminated as soon as they appear in a homozygous condition. Most of the other genes which, as well as their effects on fitness, have some visible expression, are also to some extent deleterious. The only genes

which can provide a basis for new evolutionary advances are the very rare ones which increase the efficiency of the animal.

The important point which emerges from this investigation is the presence of hidden variability due to recessive mutant genes whose effects are covered up by the simultaneous presence of the normal allelomorphs. Clearly it is quite impossible to tell what sort of variability may be present in a population merely by examining the appearance of the animals. Even if every animal looks completely normal, most of them are likely to contain one or two abnormal genes which may cause variations to appear in later generations. The raw materials of evolution, the variations on which natural selection acts, do not lie on the surface. They can only be disclosed by careful and laborious analyses. But at least we have now, for the first time, found a method of investigating them.

The Puzzle of Antlers

By F. Fraser Darling

THE outstanding fact about the antlers of deer is that they are not permanent structures on the heads of the Cervidae, the one family of mammals which grows them. The horns, characteristic of many of the ruminant mammals, to which group the deer also belong, are a product of the activity of the skin, and are a modification of hair growth. They grow as the animal grows and remain with the beast throughout its lifetime. Horns are tough masses of keratin, an extremely durable compound of nitrogen. Antlers grow from the bone of the skull and are of the same substance as bone, a stable compound of calcium and phosphorus.

It seems strange that these extensions of the skeleton should not serve the deer as long as the horns of cattle and antelopes do, for they are biologically expensive to produce. Comparatively few soils contain an adequate supply of calcium, and particularly of phosphorus, and most of the areas where members of the deer tribe are now found in the wild state are rather poor in these elements. The red stag of semi-barren Highland forests grows his antlers anew each year, though less strongly, as does his better-fed cousin in an English park or German forest.

Antlers appear during the first year of life, the young stag or fallow buck growing small points which are not unlike small antelope horns when seen from a distance; but each year, until the beast is ten or twelve years old, the new set of antlers becomes more elaborate in the number of points, in shape and in size. Thereafter, as the animal approaches senility, the antlers grow a smaller number of points, become lighter in weight and show less symmetry of curve. The bodily condition of the stag is still further reflected in the antlers which grow in the year following an injury, when the antler on the *opposite* side to that of the injury is reduced in size and malformed in more or less direct relation to the seriousness of the hurt.

The animal which grows these bony structures, that are such an expense to its constitution, does not use them all the year round, if he uses them at all. Let us take 1 April as an average date when the antlers are cast by the red deer of the Highlands, and from then trace the development of the new set.

The barren deer forest country of north-west Ross-shire

There are two patches which are to be seen at first, and these are the wounds from which the old antlers have fallen. Healing is very rapid, and a new velvety skin covers these areas in a day or two. A change can be noticed in these small centres of activity each day after that. The flat patches become convex, they bulge upwards and become almost globular, and then the soft and tender bulbs themselves appear to proliferate until the stag looks as if he had three carbuncles at the place where each antler should be. The skin covering these new growths becomes more velvety in texture and the bulbs lengthen into thick stalks.

The growth of the antlers in size is complete by about the end of July, four months after it began, and the head of the stag at this time has a charm which is soon lost afterwards. He displays as yet none of that rugged, aggressive masculinity which is characteristic of the stag in October. His neck is still slender and devoid of mane, and he has that summer redness of coat unblackened by wallowing in the peat. His eyes are mild and full, for his life now is a time of gentle grazing and restfulness in the high corries in the company of his fellows. The antlers themselves appear larger than they are in reality, for the "velvet" covers them to a thickness of at least an eighth of an inch. The stag carries his elaborate head-dress with extreme care, which we are apt wrongly to interpret as dignity. But the impression of dignity is certainly present in his comportment at this time.

This beautiful velvety covering of the antlers is not merely a slight protection to them during growth; it is the means by which they are fed as well. The velvet is rich in blood vessels so that there is a very active and thorough circulation of blood carrying the nutrient calcium and phosphorus, organically compounded and in suspension, to the receptive structure of the new antler.

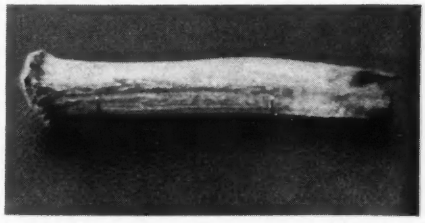
It is easy enough to state the plain facts of what occurs when the antler is full grown and the velvet becomes superfluous. That part of the antler nearest the head grows more luxuriantly on its circumference, and a beaded ring of bony tissue is formed, known as the coronet. The blood vessels which have passed upwards

between the beads of this circlet become constricted as it grows and hardens, and the temporary arteries are ultimately completely closed. But we do not know fully the physiological basis of this regulation and, as will be seen later, diversion of energy.

The velvet, now deprived of its functions and of its blood supply, quickly dies. Very soon the antlers are festooned with hanging strips of decaying skin which may be rubbed off against trees, or gently against stones, and sometimes the stag gets the end of a streamer into his mouth and may chew at it until it is torn away from the antler. This dead and occasionally stinking skin is yet rich in those elements it brought to the antlers when it was alive, and many stags do not let it lie but will eat it. This practice is common in Highland forests where, as has been stated already, lime and phosphorus are hard to find. The same fate befell the old antlers which were cast in the spring. Almost immediately the stags began to chew them, working from points to butt, and in a few weeks' time only the coronets and the inch or two of shaft above them littered the hillside. It is not uncommon to see a hind chewing the points of a stag's antlers while they are still attached to his brow.

During the four months the antlers have been growing they have been nothing but a liability to the stag they adorn. They have taxed his constitution at the end of the winter when he was least in the condition to bear the strain. Indeed, the season of April and early May is the time when many deer of both sexes die, but there is an undoubtedly higher mortality among the stags than among the hinds. It is the common experience to find the population of deer in a given area composed of females to males in the proportion of two to one, though among the calf crop the ratio is almost equal, or, if anything, in favour of the males. This differential mortality may be taken as characteristic, and the burden of antler growth is almost certainly one of the causes.

The stag is exceptionally careful of his antlers while they are in velvet. An untoward injury to them at this time causes him great distress and he loses much blood. As in every association of individuals, small differences of opinion are common among the companies of stags. Antlers are rarely used on these occasions during the greater part of the year, and never during the period of their growth. Instead, the stags settle these momentary quarrels by rising on their hind legs and boxing each other with their forefeet in the same way as the hinds do. But they do not fight in this way for long, and they are not nearly so proficient as the hinds. The photograph on p. 291 shows stags in typical attitudes during a quarrel.



(*coronet*) (*distal end*)

Chewed Antler

The stags with antlers in velvet are at a further disadvantage when the midges and blood-sucking flies become numerous. In Scotland the deer cope with these pests by going high into the hill where there is usually too much breeze for midges and the conditions are not damp enough for the blood-suckers. The reindeer of the Arctic coastal plains have no high hill near at hand where they can find sanctuary. Our red deer, by climbing 3000 ft. in three miles, achieve an effective migration which may take the reindeer some hundreds of miles to equal.

It is well known that there is a very close relation between antler growth and the gonads—testes and ovaries. In red, fallow and roe deer, where only the males carry antlers, the physiological relation is

Stags in a very early stage of growing new antlers

concerned with the testes, but in reindeer the interrelation is concerned with the ovary as well.

The whole subject can be more clearly understood by remembering first of all that the gonads not only produce sperms and eggs but sex hormone as well, for they are members of that important group of organs in the body known as ductless glands. This sex hormone, male or female, goes directly from the gonad into the blood stream and has a variety of functions, one of which is the maintenance of the secondary sexual characters of the animal. If a male creature is deprived of an adequate supply of this hormone, his bodily type, and to a certain extent his behaviour, lapses towards that of the female. For example, a cock ceases to crow and his feathering becomes hen-like; the stag does not develop his mane, his voice or the characteristic male shape. But the most obvious changes are seen in the antlers. A stag castrated when he has just cast his antlers in April will never grow them again. If the antlers are well grown but still in velvet when castration takes place, they remain in velvet throughout the year until the next shedding season, when they are usually shed, but have been known to be retained. Antlers which are clear of velvet may be shed a few weeks after castration or be retained until the next normal shedding season.

Referring to the red stag which we left at the stage of peeling the velvet from his new antlers, we find that this process is complete some time in August, and by the end of the month the antlers themselves are no longer the pale colour of bone but dark brown with white and shining points. His outward appearance begins to change from that character of mild and well-fed peacefulness which has been remarked upon already; the mane grows and the stag's neck thickens perceptibly. The facial glands below the eyes which are inactive for most of the year now secrete an odorous

They box with their fore feet instead of using their antlers

yellow mucus which trickles down the face. It is not long before the companies of stags open the peat wallows which have lain unused since April and May. The animals move about much more, and now, if there are any differences of opinion between the stags, the antlers are flourished and may be used to give the other fellow a quick dig in the ribs. Increased movement and a certain latent excitement in the herd is not conductive to a big paunch and further accumulation of fat. The stags are, in fact, eating less and their bellies become small, so that by the middle of September they are fine-looking fellows, all front as it were, but in those small hind-quarters is the strength which will give the force to that thick neck and to the challenging antlers. Quarrelsomeness is more common in the herds, and between 12 and 20 September each stag goes away on his own, a wild fellow, black from his wallowing and ready to challenge others.

This profound change has occurred in the short space of six weeks, and there can be little doubt that the energy which went to antler growth has been deflected to produce the condition of the stag in rut. The interrelation of antlers and the reproductive system is evident once more. But the gonads, the testes in this instance, do not control their own function as ductless glands bringing about the rut. Their action is initiated and influenced by another ductless gland at the base of the brain, the anterior pituitary body. It is only very recently that it has been learnt how the anterior pituitary body acts as a central control on the other ductless glands of the body. Its switchboard mechanism, which is obviously displayed in antler growth and the sexual cycle of deer, is almost unknown as yet.

Antlers are least of a puzzle to us when the stag is in rut from the middle of September to the end of October, but they still present problems not easily solved. Here is our dark-coated stag trotting forth

to the hind grounds to acquire a harem for himself. If he is one of the earliest stags in rut he may have a whole herd of hinds without opposition, but ultimately he will be challenged and will lose all but a few of them, or at least the hinds will stray to other stags and he will be unable to keep them for himself.

A stag wallow. Note the central core of bog wood

Two challenging stags come within a few yards of each other with some real or imaginary boundary between them, such as a burn or deer track. They bellow at each other, and if they come still nearer, heads are lowered and antlers presented. If they fight now the stags fence delicately with their antlers for a little while before the serious lunge forward. Each stag tries to catch the other broadside on and not be thus caught himself. The fight, therefore, is often little more than a shoving match, continuing until one is tired and runs away. Fights of long duration with serious results to either beast are rare.

The stags are often content with walking up and down the boundary of their temporary territories and roaring at each other. When two of them have adjacent harems, this course may be said to be the usual one.

Another fact of exceptional interest in the encounters between stags is that fighting does not take place unless the combatants are fairly evenly matched, and the matching applies particularly to their equipment of antlers. There is the fact, but I cannot explain it.

With all their disadvantages to the animals which bear them, how can we fit them into the scheme of natural selection, assuming that we admit this as a mode of evolution? Dr Julian Huxley, from his statistical studies of body weights and antler weights of several species of deer, has suggested that in the course of evolution antlers may have increased in size and branching with increase in the size of the deer as a species, and, accepting the evolutionary value of an increase in body size, the elaboration of antlers would not require to be of an adaptive quality in order to be controlled by natural selection. They may be merely a by-product of increase in body size.

There is one more advantage which antlers may give, as much to the species as to the individual. I have remarked on the small amount of fighting which takes place, even in the rutting season; if each stag appraises the other's antlers, it is probable and possible that this display of natural armaments is sufficient to prevent actual fighting. Deaths and damage through fighting, within the species, constitute biological wastage, and any means which prevents waste must be given its credit. The feeling remains, nevertheless, that antlers, like other armaments, are an expensive form of bluff!

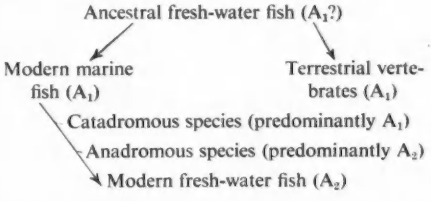
Notes of the Month

THE EVOLUTION OF VITAMIN A

The two notes below, on vitamins, provide an opportunity to remind readers of Discovery *that* (1) *vitamins are substances without which a diet, however generous, will not keep the body in health,* (2) *that the vitamins need only be present in very small amounts,* (3) *that without each vitamin a special and characteristic disease develops* (*avitaminosis is the current expression for such a disease*)*; thus the absence of A causes certain ophthalmic diseases* (*and general under-nourishment*)*, B pellagra, C scurvy, D rickets, etc.*

THREE methods are available for the estimation of vitamin A: (1) Biological, from the amount known to be required to prevent or cure xerophthalmia, an eye disease, in rats under standard conditions; (2) Chemical, by measuring the intensity of the blue colour formed by the addition of antimony trichloride; (3) Physical, by measurement of the ultra-violet absorption spectrum. With certain material these three methods have given discordant results, and, as has happened so often in the history of chemistry, these discrepancies have led to the discovery that *more than one compound possesses the general properties of the vitamin* (solubility reactions and biological activity), though they differ slightly among themselves in their physical properties. About two years ago vitamin A_2 was described from certain fishes, and now work at Copenhagen has shown that the vitamin of whale oil is neither A_1 nor A_2, but a third compound which, if its existence is confirmed, will presumably be named vitamin A_3. The carotenes, to which the vitamin A group is closely related chemically, comprise a large number of compounds whose general properties are very similar, and it is quite possible that there exists a corresponding number of different compounds all possessing the general properties of vitamin A.

A study of the distribution of vitamins A_1 and A_2 in marine and fresh-water fish has given a fresh example of the relevance of biochemistry to evolutionary problems. Occasionally a mixture of the two is found, but in most species one is present to the exclusion of the other. Marine forms, with one exception, possess A_1; fresh-water forms A_2. Anadromous species (those like the salmon which ascend rivers to spawn) and catadromous species (those like the eel which descend to the sea to spawn) possess a mixture; in the former there is a preponderance of A_1, and in the latter of A_2. These distinctions cannot be a direct response either to the salinity of the environment or to the food, since an eel and a carp living in the same pond may show completely different relative concentrations of the two vitamins. It is suggested therefore that the character is a genetic one, and that its evolution may be represented thus:



This scheme assumes that the fish originated in fresh water, and also that the modern fresh-water species represent a secondary return to that element, being descended from marine ancestors. The first assumption is generally conceded, but all

authorities would not agree to the second. If it is not true, the course of biochemical evolution must have been more complex. An examination of the vitamin A of fresh-water species belonging to families that are predominantly marine might throw more light on this matter.

D. A. W.

(*Willstaedt and Jensen, Copenhagen; Wald, Harvard*)

VITAMIN B_1 AND THE STIMULATION OF NERVES

ONE of the first sufferings definitely recognized as avitaminosis was beri-beri, the nervous disease due to lack of vitamin B_1 in the food. In the far east where large masses live almost entirely on rice, the illness could be traced to the use of polished seed for nourishment. The untreated corn contained the vital factor in its delicate veil-like envelope.

The formula of the vitamin has been discovered and its synthesis has been achieved as a crystalline compound called aneurine.

The physiology of aneurine as a factor preventing neural disturbances has been furthered by American clinicians. They found that the neuritis of drunkards could be counteracted by large doses of the vitamin, although the alcohol abuse was not suspended. The neuritis was therefore probably not a direct intoxication of nerves by alcohol but a secondary phenomenon. Chronic drunkards take in so much liquor that they scarcely eat and may get an avitaminosis due to under-nourishment; they also get inflammation of the stomach and intestines which makes, even at a normal diet, the digestion and absorption of food difficult. All sorts of neuritis have been treated in the meantime by injection of large amounts of aneurine, often with remarkable success.

Recently in Paris a discovery has been made which goes a long way towards connecting the biochemical and the clinical research done on the relation between aneurine and nervous and brain tissue. Minz and his collaborators observed that a stimulated nerve gives off vitamin B_1 in small amounts. These results have been confirmed. They will be of great value to the furthering of our knowledge of nervous excitation on the one hand, and the action of aneurine on the other.

H. L.

(*B. Minz, Binet, Agid, Beauvallet, Laboratoire de physiologie générale de la Sorbonne, Paris*)

RELIEF FOR THE OPPRESSED HEART

OPERATIONS on the heart are rightly regarded as difficult and dangerous. Modern surgical technique, however, has made it possible for such operations to be undertaken with little risk. The new heart operation in patients with angina pectoris was described in our July number last year. A further advance in cardiac surgery has been reported for the treatment of the condition known as constrictive pericarditis. Inflammation of the pericardium, the thin membrane which surrounds the heart, usually clears up completely. But sometimes there occurs a great deal of scarring of the damaged pericardium, and it tends to adhere to the heart and to surrounding organs. The beating of the heart is thus hampered and there is often too a contraction of the great veins which are bringing blood back to the heart. The veins become engorged and the tissues become waterlogged through inefficient drainage so that

the legs may swell and fluid collect in the chest and abdomen.

The new treatment for this condition is an operation in which the scarred and shrunken pericardium is removed. The chest is opened and the heart exposed. Then the damaged pericardium is carefully dissected off the heart wall and cut away piecemeal. The constricting effect of the damaged pericardium is at once removed and the heart can actually be seen to increase in size and contract more efficiently during the operation.

Three cases have recently been submitted to the operation in London. Although all three developed complications after the operation, they made a good recovery. One was only partly relieved but the second was considerably improved and the third completely cured. J. Y.

(*Hunter and East, London*)

THE NATURE OF POLISHING

THE usual method of polishing surfaces is to rub them together with a fine powder between them. The classic work of Beilby has shown that by this means a "vitreous" layer is formed on the surfaces and that this layer appears to have flowed over the surface irregularities. However, the underlying mechanism of this process has been a subject of debate for many years. Most authors have considered it to be essentially a process of abrasion although it has been suggested that polishing might be due to a surface melting of the rubbing solids.

Some earlier work of Bowden and Ridler had shown directly that the temperature of the surface layers of sliding solids can be very high and may easily reach the melting-point of the solids. This suggested that the latter hypothesis is the correct one and that polishing is in fact due to an actual melting or softening of the surface irregularities as a result of the intense local heating at the points of contact between the rubbing solids. The molten or softened solid flows or is smeared over the surface and very quickly solidifies to form the polished Beilby layer. However, the surface temperature cannot rise higher than the melting-point of the surfaces, so that it seems likely that polishing would occur only if the melting-point of the polisher were higher than that of the substance being polished. The recent experiments of Bowden and Hughes have shown that this is indeed usually the case. Thus camphor (M.P. 178° C.) polishes Wood's alloy (M.P. 70° C.) but not tin (M.P. 232° C.). Similarly oxamide (M.P. 417° C.) polishes tin, lead (M.P. 325° C.) and bismuth (M.P. 269° C.) but not speculum metal (M.P. 745° C.). These experiments showed that, contrary to the earlier theories, the relative hardness of the solids is comparatively unimportant. Thus in the above examples camphor is almost as soft as butter but it is able to polish the very hard Wood's alloy because the melting-point of the metal is lower than that of camphor. On the other hand tin, which is softer than Wood's alloy, is untouched because its melting-point is higher than that of camphor. L. L.

(*Bowden and Hughes, Cambridge*)

SEEING IN THE DARK

WHAT is the colour of your eyes? Applicants for driving licences are not—up to now—asked this question, but it would not be an unreasonable one. Some interesting investigations have recently been made into the differences in reaction to light in people

with different coloured pupils. The results showed that, compared with dark-eyed persons, those with light-coloured pupils are under a two-fold handicap when driving at night. In the first place, their eyes are not so sensitive, so that they cannot so easily perceive dimly lit objects; secondly, they are more affected by glare, so that they are more readily dazzled by the headlights of an oncoming car. This, of course, is quite apart from true night blindness, caused by a deficiency in vitamin A, which will make anyone, irrespective of eye colour, see poorly in the dark. J. Y.

(*De Silva and Robinson, Harvard, U.S.A.*)

CULTURAL RELATIONS AND ETHNIC MOVEMENTS BETWEEN BRITAIN AND BRITTANY IN THE FIRST CENTURY B.C.

An archaeological excavation, brief in duration, though of the greatest interest in its result, was carried out under the direction of Dr R. E. Mortimer Wheeler on Gurnard's Head, near Falmouth, in the fortnight ending 24 April. The site is a fortified headland containing a number of hut-circles, which were found to have been protected from attack on the landward side by a series of three ditches running across the peninsula. In these ditches the innermost rampart, which was faced back and front with stone, on its inner side was constructed in three steps. The wall-stones of the hut-circles were of remarkable size. Although the fort manifestly had not been permanently occupied, but had served only as a place of refuge in emergency, there was evidence for the presence of women in the form of a pottery spindle whorl. Among a quantity of sea-rolled pebbles was a number of sling-stones; and the pot-sherds included fragments showing the characteristic curvilinear decoration of the first century B.C. One sherd with the "duck" pattern resembles a find made by Mr E. T. Leeds at Chun Castle, a site four miles away.

The interest of the investigation lies not so much in the intrinsic importance of any individual find, as in the light the evidence as a whole throws on the cultural and ethnic relations of south-west Britain in the first century B.C. It will, perhaps, be remembered that when Dr R. E. Mortimer Wheeler was excavating Maiden Castle, near Dorchester, on behalf of the Society of Antiquaries and the local archaeological society between 1934 and 1938, he found that in the final phase of the occupation of this great fortified site, before it succumbed to Roman attack, a new civilization of unknown origin appeared there in the first century B.C. Its most marked characteristics, now appearing here for the first time, were the employment of multiple lines of fortification for defence and an intensive use of the sling-stone as a means of attack and defence. In the search for the origin of this new and highly organized civilization, appearing suddenly in south-west Britain without local roots, the source which naturally suggests itself is Brittany, especially as recent archaeological discovery in our south-western counties points to a cultural, and even ethnic, connexion between southern Britain and Brittany in the preceding prehistoric periods, going back certainly to the Bronze Age. Accordingly in the summer of 1938 Dr Wheeler began a series of archaeological explorations in Brittany, in the hope of discovering a civilization of an analogous character to that which he had found at Maiden Castle. In northern Brittany his search was unsuccessful. Although two forts of Iron Age date resembling those of Wessex were found, they were not of the type of which he was in search. In the south-west, however, as he recounted recently before the

Society of Antiquaries of London, along the coast between Douarnenez and the mouth of the Loire he found a number of fortified sites, which in their triple lines of fortification and the use of the sling-stone, as well as in other respects were completely comparable to the fortified site of the final phase of Maiden Castle.

Dr Wheeler's interpretation of the evidence is that when the Veneti, those troublesome opponents of Caesar by land and sea, were broken by the Roman attack, some of the chiefs gathered their scattered followers together and sailed for Britain, following in the track of earlier traders and prospectors, to settle in Wessex and on the headlands along the south-western coast as far as Cornwall. The triple line of ditches fortifying the peninsula of Gurnard's Head, the stepped rampart, which also appears at the fort of Kercaradec in Brittany, and the use of the sling-stone is strong presumptive evidence of a connexion between the Veneti of south-west Brittany and Cornwall in the first century B.C. It is possible, however, that the fragment of "duck" pottery, to which reference has been made, may point to an earlier continental connexion, as Mr Leeds holds that the Chun Castle site affords evidence of a relation, due to the ancient mining industry, with northern Spain. E. N. F.

(*Mortimer Wheeler, Society of Antiquaries*)

CELEBRATIONS AT LES EYZIES

EARLY in April M. Peyrony, founder and curator of the Museum at Les Eyzies, France, celebrated his 70th birthday. M. Peyrony has done valuable work in dating and identifying excavated human debris in the rock shelters there, and prehistorians from all parts of the world, among them the Abbé Breuil, met at Les Eyzies to celebrate the jubilee. A report of the excavations at Les Eyzies is given on the next page.

The photographs above show, left, the Château Museum of Les Eyzies, and right, M. Peyrony speaking at the jubilee celebrations.

The Vézère valley. Les Eyzies is in the centre of the photograph

A Domain of Cromagnon Man

By R. O. D. Noone

(In this article Mr Noone, who is a member of the Cambridge University Speleological Society which recently attended the celebrations at Les Eyzies, France *(see p. 297)**, gives an account of investigations of prehistoric and medieval remains there.)*

Less than a century ago, a modest little village in the Dordogne, France, nine hours' train journey south-west from Paris, was practically unknown, yet it is to-day often referred to as the "Metropolis of the Prehistoric World". In the deep valley of the Vézère river, at a rock-shelter known as "Cromagnon", situated between the eleventh-century fortified Church of Tayac and the village proper of Les Eyzies, an accidental discovery of skeletal remains was made in 1868. These provided science with definite evidence of the kind of man who was responsible for the local deposits of a highly developed flint and bone industry, and even objects of art, which a few years before had been brought to notice by MM. Lartet and Christy. Study of the skeletons showed that the man who had taken up his quarters at Cromagnon 30,000 years ago was one of our early ancestors; subsequent research has led to the even more startling fact that this neighbourhood already knew of an earlier type of man, as far back perhaps as 30,000 years before that. Other evidence has now shown how, constantly through the ages, with his different stages of culture (Tayacian, Micoquian, Mousterian, Perigordian and Aurignacian, Solutrean, Magdalenian, Azilian, Robenhausen and Historic times), man has chosen this region as a dwelling place. Various animals, some now extinct, and of different climes, have visited and thrived also in this vicinity, for remains have been found of lion, hyena, mammoth, rhinoceros, bison, horse, reindeer, banded lemming, and others.

In the bed of the valley the age-old Vézère river meanders from side to side, between a succession of steep cliffs and terraced slopes. Perhaps the most conspicuous features of these cliffs, in some places 400 ft. high, are the deep undercuts which run horizontally, sometimes for a considerable length, in conformity with the bedding of the Jurassic limestone. Their depth in the cliff face reaches as much as 30 ft. at certain spots. This natural feature afforded early man a cosy shelter and homestead, especially during the cold cycles of the later Palaeolithic period. The

plateau above and the river below provided sources of food, whilst within easy reach a spring of cool water could be found, seeping through the limestone wall, and, above all, ample supplies of flint (chert) with which to make his implements were near at hand.

The Museum, where the finds of the district are very systematically exhibited, is the medieval Château of Les Eyzies, and was formerly the home of the Lords of Beynac. Perched on a broad terrace halfway up the cliff, this solid structure has been found to rest on layers of kitchen refuse, flint chips, and the bone and stone implements, discarded or lost by the men of the Magdalenian period some 120 centuries earlier. The Museum and its collections are an eloquent testimony to the enthusiasm and industry of that famous savant M. D. Peyrony. A magnificent panorama of the river valley may be viewed from the restored upper "Salle". Slender pyramidal poplars and soft grey willows outline the modern course of the river, and enclosed in its curves are seen, in due season, rich growths of planted tobacco and maize, with patches of deep red-tipped clover and golden cereals, whilst here may be seen the cool green of walnut trees. Up the slopes, caressing the pale yellow and grey of the limestone buttresses and cliffs, chestnuts, oaks, acacias and hazels flourish. Surmounting all hangs the plateau edge with its dark evergreen oaks and junipers, pinnacled by a few pines and firs.

At La Micoque, a mile to the north behind the little hamlet of Le Mas, excavation has shown six stratified deposits of earliest man's residence extending to a depth of 26 ft. and containing remains known as Tayacian and Micoquian. The older layers show a crude flake industry of small, nondescript flint implements, but in the top layers are found the elegant "Micoquian-type" *coup de poing*, a bi-faced flint implement fashioned into a deftly pointed lanceolate shape.

Skeletal and Cultural Remains

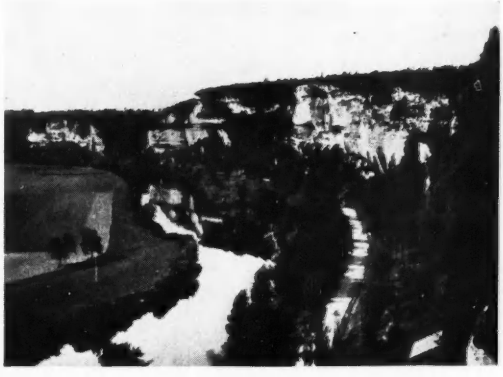
A little below this valley the Vézère flows in a bold sweep to the south-west, passing on its way the hamlet of Laugerie. Here are two main habitation sites of particular interest, the rock-shelters of Laugerie Haute and Laugerie Basse. The former was first occupied during a period of severe cold that set in many centuries after the La Micoque shelter had been abandoned. Judging by the skeletal and cultural remains, a new race had appeared on the scene and great strides had been taken in human development. Craftsmanship and tastes are expressed in the variety and specialization of implements and in the articles of adornment, and even art, that have been recovered. After occupation

Map showing places of prehistoric and medieval interest near Les Eyzies (France)

here extending off and on for some 200 centuries, with a procession of what are known as the Perigordian, Aurignacian, Solutrean, and early Magdalenian cultures, the shelter was overwhelmed by disaster due to the breaking away of enormous blocks of the limestone overhang. In their terror some of the Magdalenians took refuge farther up the river, at the rock-shelter of La Madeleine. Others went to Laugerie Basse, and there one finds successive habitation layers extending from middle Magdalenian, through the Mesolithic, Neolithic and Gallo-Roman, up to the Middle Ages, and even to-day. The majority of the finds here are on view in a museum on the premises, including bone harpoons and needles, and engravings on stone, bone and antler. At these Laugerie sites "witnesses" have been carefully preserved to show the student, by means of a vertical exposure, the superimposed layers, containing the remains *in situ* of each distinct culture. On occasion large blocks of limestone are found during excavation, which, by their position and propinquity, suggest that these rock-shelters were improved and protected by constructed barriers or walled enclosures. Skin and branches and even artistic adornment were also probably employed.

Near here there is a famous stalactitic cavern, with its entrance some 100 ft. up the cliff, and farther on is a sinister valley with a vast open cavern, like a black gaping void, called the Gorge d'Enfer.

At the entrance to the straggling village of Les Eyzies under a rock-shelter is the Hotel de Cromagnon, built alongside the site where the world-famous family of skeletons, of the Aurignacian culture, was found during the construction of the railway. The origin of this name is claimed to be from the patois, thus, Cro = hole, and Magnon = Magne, the name of an old woman, perhaps a witch; so we have "The old Magne's Hovel". The human remains found here were of an old man, a young woman, a boy and two others, but unfortunately these last were mishandled by the railway navvies. Some of the bones were stained with red ochre, and accompanying them was a quantity of marine shells of a kind now common on the Atlantic coast. Judging by their physical characteristics here were people, very little different from ourselves, who were in existence some 300 centuries before us. In the then stage of knowledge this find was of the greatest significance to prehistory



The Vézère flowing past the cliffs of Laugerie

Six kilometres away up a side valley of the Vézère is the shelter of La Ferrassie. Here MM. Peyrony and Capitan found five skeletons of a still earlier type of man, *Homo Neanderthalensis*, with a heavy coarse-looking skull, showing protruding jaw and low bulging brows. Two adult and four infant skeletons, one new born, were found directly below a deposit of the Aurignacian period industries, and in association with implements of the Mousterian culture. These people preceded Cromagnon man, and were of a more primitive type. The skeletal remains of the children were lying in small hollows, one of them, with the skull detached, under a block of limestone bearing ten cup-shaped depressions, arranged in pairs around a larger one. Experts consider this design artificial, in other words recognize it as one of the very first examples of human art.

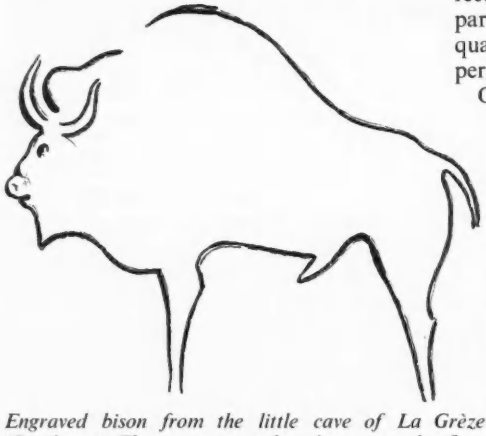
The term "Cave man" is a misnomer if used in connexion with the later Palaeolithic cultures of the Dordogne, except in so far as he made use of caves by adorning the galleries with his mystical mural art and portraiture. With the many rock-shelters exposed to the sun's warmth that were available (those selected were almost invariably facing east to south), damp and dim caves were not favoured as residences.

The Two Forms of Art

Prehistoric art took two forms: (i) Home and Chattel art, that is, engravings and carvings on portable objects, such as bone, antler, ivory, pieces of schist and limestone, which are found actually in the stratified deposits; and (ii) Mural art, such as sculptures, engravings, and paintings on the cave walls. The first signs appear in the Aurignacian period, steady progress taking place till remarkable realism and mastery of line are achieved. Towards the end of the Magdalenian period accuracy noticeably falls away, and idealism and stylization take its place, though a few good paintings in polychrome were produced. Animals are the subjects most frequently portrayed, but human shapes do occur and there are some tectiforms. Whilst the Aurignacians were more successful in modelling the human than the animal form, the reverse is markedly apparent in the case of the Magdalenian artists. The

pendant hooves noticeable in several of the engravings imply that it was the practice of the artists to work sometimes with animal models lying before them. The coloured work is in both monochrome and polychrome, a fatty medium being used with black manganese and red and yellow ochre.

There are two instances of sculpture in relief which are exceptional in being in rock-shelters in place of caves—the salmon of the Gorge d'Enfer, and horses of Cap Blanc. The latter is attributed to the early Magdalenian period, and is a very impressive life-size composition with six chief figures in high relief. On the left are two horses facing right, the hindquarters of the leading one being masked by the other in the foreground. A larger horse faces them at a higher level. This is very exquisitely modelled in masterly curves. In length it is about 7 ft., the relief standing up as much as 12 in. This horse is the outstanding feature of the work and shows traces of adornment with the sacred ochre. Balancing the composition are three horses on the right, two facing in that direction, and then one the other way. The floor below is reported to have been levelled with stone slabs. Have we here the apotheosis of the horse, as expressed by a master craftsman? Is it a tribal totem? During the excavation a female skeleton of the Magdalenian folk was found buried almost at the centre of the shelter floor. Cap Blanc remains an artistic gem and a mystery.

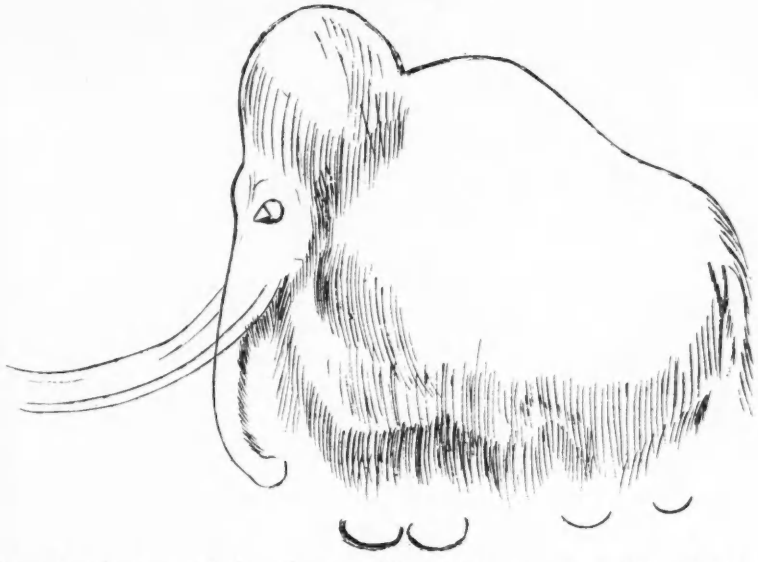


Engraved bison from the little cave of La Grèze (Dordogne). The engraving is low down near the floor of the cave and was completely covered by deposits containing Solutrean implements

(Burkitt, after Breuil)

The first painted cave to be recognized as such in the Dordogne was La Mouthe. Not long ago the entrance to this cave was used as a wine cellar, and it was while enlarging this that the proprietor came upon an extension of the cave, blocked by deposits containing Magdalenian debris. The designs themselves are very varied and well preserved. The first engravings seen are horses, deeply incised, and reminiscent of Aurignacian technique. Farther on the engravings become finer and shallower with more detail, indicating a later date. Horse, mammoth, reindeer, bison, and ox are faithfully depicted here, while in a little recess near the end is a tectiform design, partly painted, which seems to be a three-quarter view of some sort of a structure, perhaps a wooden framework or a trap.

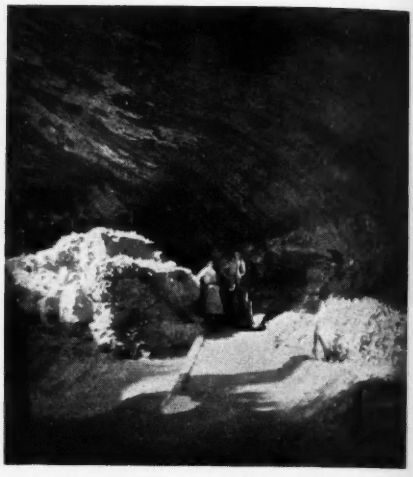
On the eastern slope of a little valley leading into the Beune, just outside the village, is the cavern of Font de Gaume. It contains many fine paintings in monochrome and polychrome, some partly desecrated by early tourists' scribblings. From the technique made use of in the drawings, and other evidences found in the cave, it is deduced that it was used for art from Aurignacian to Magdalenian times. Most of the usual animals are to be found here, in some cases as many as three being superimposed. The best examples are near the end of the cave. A bison drawn in black manganese is so well done that one finds oneself expecting it to turn its head to see what is approaching. Farther on is one of the few representations of the rhinoceros, partly done in red ochre, but belittling all others is the "Salle des bisons" in which there are no fewer than thirteen of these animals, some in extraordinary attitudes, engraved



Engraving of a mammoth, from the cave of Font de Gaume near Les Eyzies. (*Burkitt*)

An example of mural art. A polychrome painting of a reindeer, from Font de Gaume. (*Burkitt, after tracings by Breuil*)

Modern houses built under the limestone overhang at Laugerie



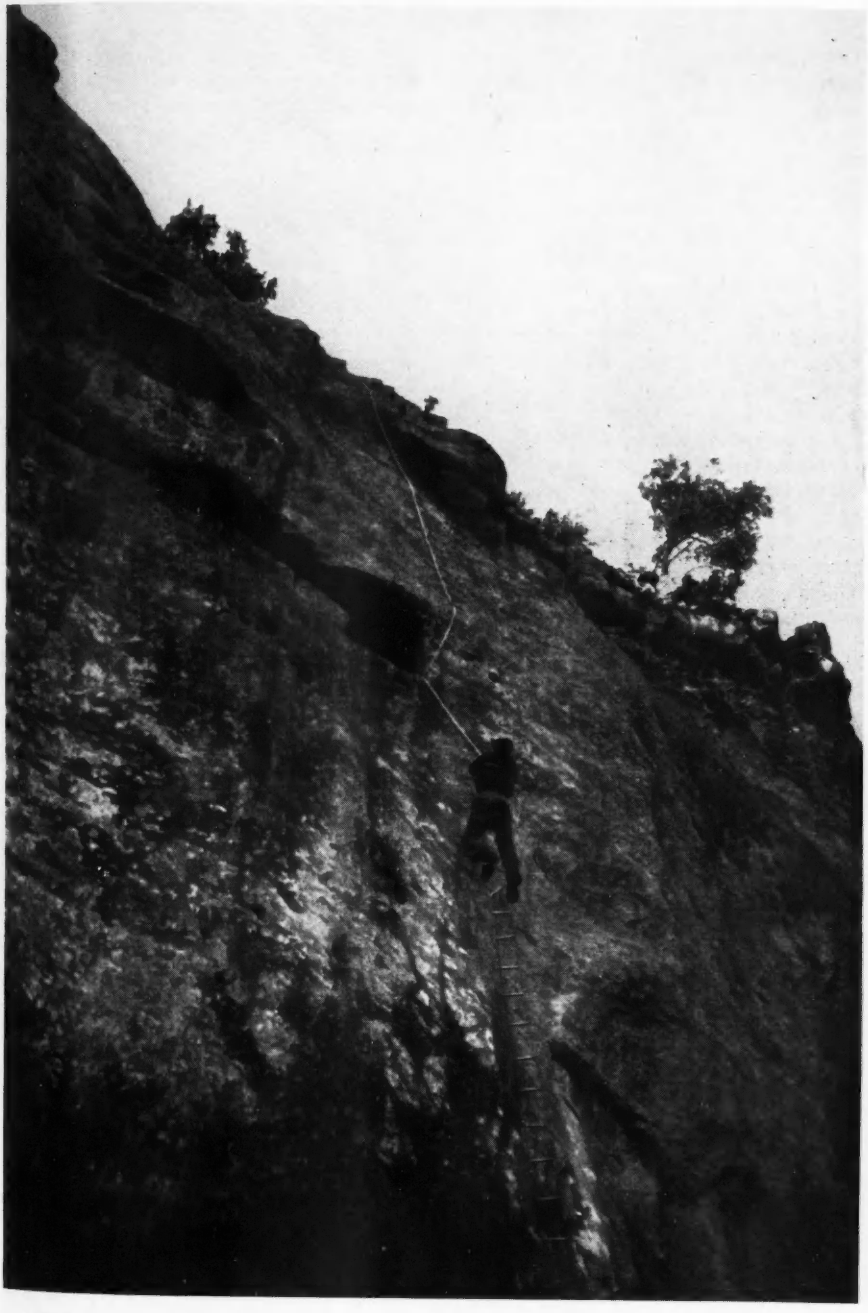
The rock-shelter of Laugerie Basse, showing the depth of the under-cut

Laugerie Haute, showing the trench of excavation

Laugerie Haute, Côté Est. Note the depth of deposit and the "witness" left for future excavation

and painted in black. Unfortunately a few are covered by a thin layer of calcareous deposit from the vault and the wall above. Perhaps the most beautiful of all the paintings is the scene in polychrome of two reindeer facing each other, the female kneeling, and the male standing upright, sniffing at her in anxious sympathy. There are many others which are difficult to recognize at first, but whose shape leaps to the eye after careful synthesis.

A little farther up the Beune valley is the cave of Les Combarelles, standing a short distance back from the road up a small side



Climbing up into the medieval rock fort of Le Peche St Sourd, forty feet above ground level

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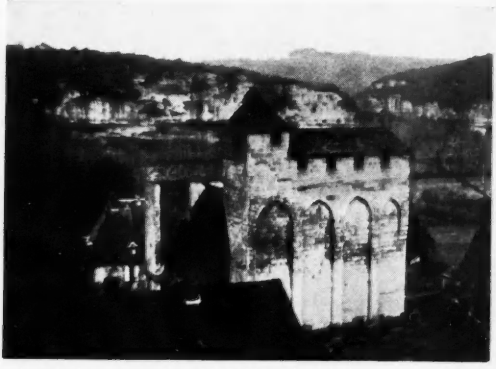
valley. Here there is a veritable zoo of animals along both walls. Horse, mammoth, ibex, deer, reindeer, antelope, cave-bear, bison, wolf, fox, and lion, tectiform designs and anthropoid figures, all of which help to throw light on the conditions of upper Palaeolithic times. There are more man-like figures in this cave than in any other. It is claimed that about forty can be traced after persistent search, some of which appear to be masked, perhaps as a form of hunting camouflage, or with some ceremonial significance.

Of the many other decorated caves, La Grèze (not far from Cap Blanc) is worthy of particular note. Only a few animals are depicted here, but the best is a fine Solutrean engraving in line profile of a bison, which is indeed a virile and noble specimen.

There are other sites of prehistoric interest round Les Eyzies, not so important as those briefly mentioned above, but all of them contributing in some way to the pages of our past history.



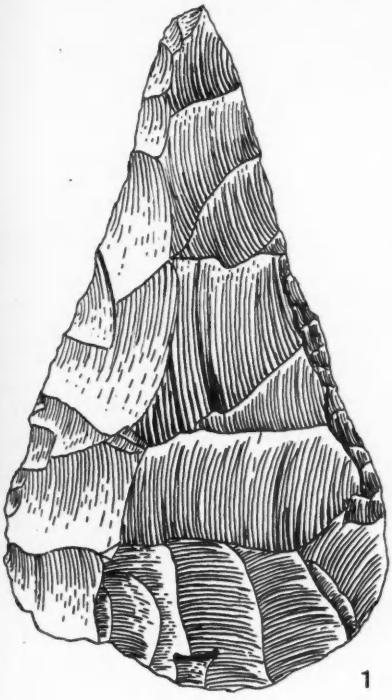
The XIth century fortified church of Tayac, showing the cliffs of the Roc de Tayac in the background

Medieval Dwellings

The people of the Middle Ages were especially attracted to this district, for we find evidence of them in the many rock forts hewn out of the limestone cliffs, and in the remains of their villages. At the Roc de Tayac, between Les Eyzies and Laugerie, they fortified an existing terrace half-way up the cliff face. With the river flowing at the bottom and a considerable overhang above, they were in an almost impregnable position. On what little ground there was between the foot of the cliff and the river's edge, they built their houses. The beam holes and the roof-line supports in the face of the rock, the long diagonal channels cut to deflect the downwash, functioning as the eyebrow, and a few oblong excavations, which presumably served as sleeping niches, are all that remain of them to-day. From the terrace above to the river level below, there is a deep well sunk through the limestone, which kept them supplied with water during a siege. They also had a way of retreat up to the plateau above, by means of iron rungs, still visible to-day, driven into the wall of a funnel in the rock. Local gossip has it that this fort was held by a medieval band of robbers, who levied toll on anyone passing along the river below, and there they thrived until certain English bandits smoked them out.

Within view down the river but on the opposite bank is another medieval outpost, the stronghold of Le Peche St Sourd, placed about 40 ft. above ground-level. Here there was no terrace in the cliff, so, working inward from the bare face, they pecked out their rooms and passages. From the windows, balconies were built out, as witness the holes for the supports remaining to-day.

The Church of Les Eyzies is a little over a kilometre north. Seeing it in its setting of old cottages, some still stone roofed, huddled behind on the slope of the hill, one has the feeling of being taken back to the Middle Ages. The church itself dates back to the eleventh century, is strongly built and has a secret underground passage giving access to a cave. It has been strengthened for defence by lofty towers at each end which have the appearance, at



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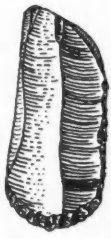

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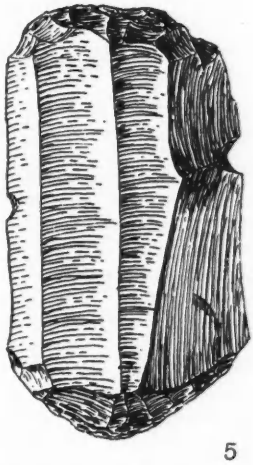

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Fig. 1. Hand axe of the La Micoque type, from Swanscombe, England (University Museum of Archaeology and Ethnology, Cambridge)

Fig. 2. Solutrean "Laurel-leaf" spear head, showing pressure flaking

Fig. 3. Magdalenian harpoon of bone

Fig. 4. Upper Palaeolithic Endscraper-Burin. The Burin is the chisel-like upper end, probably used for cutting bone

Fig. 5. Aurignacian Double-Endscraper of jasper, from La Ferrassie

a distance, of enormous megaliths with the nave of the church as the fallen lintel stone. Supporting the arch at the main entrance are two plain marble columns, reputed sole relics of a Roman temple, at one time somewhere in the vicinity. In the outside wall at the back is a block ornamented by a scroll of characteristic Merovingian decoration.

From the Les Eyzies Château terrace can be seen the Rocher de la Peine, like an enormous mushroom. Immediately below the Château is a lane, still much as it must have been during feudal times, and even to-day many of the residents live as did their medieval forerunners, with the cliff face as the back wall of their home.

FLOWER PROBLEMS. II

(The study of flowers is one of the sciences open to the amateur, it needs a keen eye, a good memory, and little expensive equipment. Discoveries are constantly being made in the field, and there are a good many problems in which accurate observation and record can be of the greatest help. As announced last month, it is hoped that non-technical articles by botanists may appear here from time to time, dealing with individual plants and the particular questions they raise.)

The Lesser Celandine

By Dr H. GODWIN

No field botanist need go to the Himalayas or to Peru to find new plant problems for investigation, almost any common plant can challenge our lack of knowledge, and Dr Valentine's account of the butterbur in last month's *Discovery* has shown that there is still much to learn and verify about the characters of our own familiar flowers. Problems raised by new work on the lesser celandine will bring the fact even nearer home, for the celandine is the commonest of spring flowers—and nearly everyone from childhood has known its glossy heart-shaped leaves and brilliant varnished yellow flowers. It is seen almost anywhere during March, April and May in damp hedgerows, pastures, and woodlands in England, and it is therefore hardly necessary to describe it here in detail.

"Pilewort" is its old country name, derived (one supposes) from the characteristic cluster of small tubers that grow out from the base of the stem just below ground-level. These tubers are modified roots, very easily broken off, as gardeners know well enough, and each is capable of becoming a new young celandine plant—which therefore commences life with considerable capital in the form of stored food.

The family to which the lesser celandine belongs—Ranunculaceae—is one which stands very close to the borderline between the two great groups into which flowering plants are naturally divided. Plants of the group known as monocotyledons have one seed-leaf or cotyledon in the germinating plant, and have also narrow parallel-veined leaves and flowers with their parts in threes but without separate calyx and corolla; they never form trees; they include the grasses, sedges, lilies, and daffodils. The other group, the dicotyledons, with two seed-leaves, have net-veined leaves, and their flower parts (often consisting of both

Fig. 1. Less
Hauxton, C
formed from
broad petals

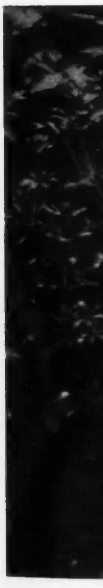

Fig. 2. Less
Goosegrass
f 3·2 $\frac{1}{20}$ Ag
fertile, and
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11 a.m. and

Fig. 1. Lesser Celandine. *A solitary plant growing in a sunny situation by a lane-side ditch at Hauxton, Cambs. (Leica f* 4·5 $\frac{1}{30}$ *Agfacolour film.) Three weeks later fertile fruits had been formed from these flowers, and no bulbils were to be found in any part of the plant. Note the broad petals and, in the flower on the right, the reflexed stamens and exposed ovaries*

Fig. 2. Lesser Celandine, *var.* bulbifera. *One of a colony of plants growing in thick herbage of Goosegrass and Fool's Parsley on a shady bank above a stream at Hauxton, Cambs. (Leica f* 3·2 $\frac{1}{20}$ *Agfacolour film.) Three weeks later these flowers were found to have been entirely infertile, and many bulbils were found in the axils of leaf and stem. Both pictures show the plant and situation as found, with nothing touched or removed. Photographed 8 April 1939 between 11 a.m. and noon*

Fig. 3. *Two shoots of var.* bulbifera, *showing the small tubercles* (*bulbils*) *in the axils of the leaves of flowering shoots. In one shoot the floral leaves have been shed, in the other this process is just beginning*

green calyx and coloured corolla) are most commonly in fives.

Now the celandine, although a "dicotyledon", gives interesting evidence of a relation to the monocotyledons. Like many monocotyledons it favours moist places. The anatomy of the tuberized roots and stems lacks any tissue capable of secondary growth like that which causes the continually increasing thickness of stems and roots in most dicotyledons and forms the timber of forest trees. More oddly still, in the early stages of germination (very abundant in some places) the celandine shows not two but a single cotyledon. Thus in the very character that gives the major group its name the celandine is, so to speak, heretical; it is monocotyledonous in its infancy.

This single seed-leaf is heart-shaped, attached to the stalk at its point, and notched at its wider end, and the notch has led to some speculation as to whether the leaf may really be two fused cotyledons. The anatomical evidence, however, does not suggest this.

The lesser celandine flower has a perianth of units or flower-leaves of two kinds, the three to five outer ones are green, and the seven to thirteen inner ones are glossy and yellow, and bear a small scale-like nectary at the base: this is clearly comparable to the nectaries in the Christmas rose (*Helleborus*) and winter aconite (*Eranthis*), and the units or "petals" are spoken of as the honey-leaves. The numerous stamens of the celandine cluster round the ovaries in the middle of the flower, and at first they are

all erect. The outer stamens open first and thus leave a clear path to the nectaries for visiting insects. As soon as the stamens have shed their pollen they bend over towards the petals so that the path to the nectaries is always bordered by stamens dropping ripe pollen. The receptive stigmas of the ovaries mature later.

The flat openness of the celandine flower makes both pollen and nectar easily acessible to short-tongued insects, and many kinds of beetles, bees, wasps, moths, and flies have been seen visiting the flowers. It appears that the insects visit only in sunny and warm weather, and cease to come in dull, cold, or wet weather. (It is worth recalling here that the celandine flowers in the early and uncertain months of spring.) Insect visits are certainly of great importance, for experiment shows that a lesser celandine flower fails to set seed when pollen from its own stamens is transferred to its ovaries.

A recent paper by Mr Marsden Jones has drawn attention for the first time to the fact that in Britain the lesser celandine exists in two distinct forms. One of these (which Mr Marsden Jones proposes to call variety *bulbifera*) bears in the axils of many of the leaves single small solid ovoid bodies known as bulbils. These are modified root structures swollen with stored food, and when they are set free they give rise to new young plants. In passing it might be worth recalling that bulbils occur more generally in plants of the monocotyledon group. The special characteristic of producing bulbils in this new variety of celandine goes with other fairly constant recognizable characteristics: the honey-leaves (or petals) are narrower than in the other variety and do not overlap, and the stamens and ovules are fewer in average number. More important is the fact that *bulbifera* * sets only a very small proportion of good seed, and must in the natural state rely upon reproducing itself by means of tubers and bulbils. But if a cut flowering stem of the bulbil-bearing celandine is kept in water, and all bulbils are removed as soon as they appear, it is found that more fertile seeds then appear. This experiment supports the notion that the failure of *bulbifera*

Fig. 4. (*Left*) *A single head of var.* bulbifera *showing a single fertile fruit* (*large and swollen on the right*) *out of the many ovaries on the head. Even so this fruit will probably contain a non-viable seed*

(*Above*) *A small celandine plant from a garden, showing the cluster of root tubers at the base of the stem. An old tuber is seen, large and withered, at the back, the rest are younger. The kink in the stems of the leaves is due to the plant having been buried an inch or two below the soil after it had begun to grow*

* Although not strictly in accordance with scientific practice, we have used the term *bulbifera* in this article, in place of the more cumbrous exact form:

Ranunculus Ficaria L. var. *bulbifera* Marsden Jones.

to produce good seed may be due to the diversion of food to the bulbils.

Seeds from the *bulbifera* variety, when they do germinate, always grow into new plants of the same variety; and seeds from non-bulbil-bearing plants produce seedlings exclusively of their own kind; in fact, the two varieties are clearly two populations differing from one another in their hereditary make-up—a difference that is confirmed by microscopic examination of the cells. When cells divide there can be recognized and counted in each cell the minute chromosomes, which bear the genes or factors primarily responsible for the transmission of hereditary characters. The microscope shows that the cells of *bulbifera* have four sets of chromosomes (tetraploid), and the cells of the other variety only two sets (diploid). We may suppose that the variety *bulbifera* arose from the diploid form by a sudden duplication of chromosome sets; such an event has probably been concerned in originating many new wild and cultivated plants.

Besides being endowed with these several new characters of form and reproductive habit, *bulbifera* seems also to have developed new needs. The ordinary celandine will grow in a very wide range of conditions; *bulbifera* seems to be confined to shady and damp places. But perhaps it is too early to be certain of this, because *bulbifera* has not long enough been clearly recognized. Detailed information about the distribution of *bulbifera* must now be collected and analysed. Who knows what new principles or new problem such collected information may not engender?

Letters from Readers

Nutrition and Health

THE interesting articles by Mr March raise questions which I hope he will clear up.

(1) What exactly is the function of protein in foods? If it is to make new growth or build up again wasted tissues (as appears to be implied by him), why do children who are growing rapidly require less meat than adults who have stopped growing and, moving about much less actively, presumably lose less tissue by waste?

(2) If the main criterion of the value of a food is, apart from any protective character, shown by the number of calories produced on combustion, as the stress laid on this by physiologists appears to imply, why do people of hot climates eat less meat in comparison with carbohydrates than do those of temperate climates, and those of arctic regions far more?

(3) Mr March turns down quite definitely the idea of "night-starvation". I find that I wake up fresher in the morning if I have had something to eat just before getting into bed, than if I retire three or four hours after dinner having eaten nothing since, and feeling hungry. This may be due only to sounder sleep, for eating a biscuit is sometimes an aid to sleep, I suppose because the blood is then drawn from the over-active brain. This supposition and the memory of hungry evenings complete with mentally vigorous days and of dullness following a full meal, make me wonder whether food just before sleep may not by drawing blood from the brain result in denying to the brain its necessary refreshment, and so be really a bad thing. The brain is so much the most important part of our bodies that the question is worth considering. Has Mr March any light to throw on it?

P. F. FYSON, Hooe, Plymouth.

(*We sent Mr Fyson's letter to Mr March, whose now completed series of articles on "Nutrition and Health" has been running in* Discovery *since August last year. Mr March's reply is given here.*)

THE questions raised by Mr Fyson are of

considerable interest and I hope my answers will prove helpful to him.

(1) I think that the statement that children require less meat than adults is only partly correct. They may not need as much meat but they actually require more protein which is the principal food constituent of meat. They need protein not only to replace worn-out tissues but also to supply material for growth. It should be remembered that a five-stone child is less than half the weight of the average man and the amount of protein required is dependent upon weight. Also meat is not the only source of first class protein for the child. It is probably obtaining an appreciable percentage of its requirement in this direction from milk.

(2) My experience of diets in tropical climates is that most of the inhabitants tend to cut down on all foods which supply a large number of calories. Persons living in such regions obviously require less energy in the form of bodily heat than those, for example, in England in the middle of winter, where heat is lost to the atmosphere most of the time. In the tropics, foods containing a high percentage of water should be eaten; such as salads, fruit, etc., although of course some meat will be required too. In Arctic regions one of the chief reasons for eating a large amount of protein is that it is very difficult to get any other food but meat. Practically the only carbohydrates obtainable by such persons comes from the glycogen in the livers of animals they eat, and from moss. They also eat a great deal of fat which provides twice as many calories weight for weight as carbohydrate.

(3) The body requires a certain number of calories per day. Once they are consumed there can be no talk of starvation, "night" or otherwise. It is of interest, however, that the content of sugar in the blood rises soon after the consumption of food, stays at that level for a time, and then slowly descends to a low level. A low blood sugar is consistent with a feeling of lassitude and sometimes of malaise. Some persons are more susceptible to a low blood sugar than others, and these are the people who probably feel better in the morning if they have a little food before retiring the night before.

The relation between food and the brain is somewhat obscure. It may be of interest, however, to know that the chemical composition of the brain is remarkably constant even in extremes of starvation and overfeeding.

C. H. MARCH.

Thermit

I SHALL be extremely obliged if you will kindly give me informative replies to the following questions:

(1) What is the maximum degree of heat (Centigrade) attained by combustion of *magnesium* in ribbon or powder form?

(2) What are the constituents of THERMIT?

(3) What is the maximum degree of heat (Centigrade) attained by the combustion of THERMIT?

F. T. S. BUNTING, Hastings, Sussex.

(*These questions were included in a letter to the Editor. As they are of such obvious immediate public interest, we give the answers in order below.*)

(1) The temperature of burning magnesium varies with the conditions, but is of the order of 1500° C.

(2) The constituents of THERMIT are aluminium and iron oxide (Fe_2O_3). An ignitor such as magnesium ribbon is used and combustion started by dipping it into a mixture of aluminium powder and barium peroxide. During the combustion the iron oxide (Fe_2O_3) is reduced to iron, and so much heat is evolved that both the iron and the aluminium oxide (Al_2O_3) which is produced are formed in the liquid state. The reaction is

$$2Al + Fe_2O_3 = 2Fe + Al_2O_3.$$

(3) The temperature attained during the combustion of THERMIT is about 2500–3000° C.

The Science of Washing

WASHING is such an everyday occupation that it is difficult to appreciate that the removal of dirt and grease from textiles with soap solutions is a scientific process. A considerable amount of research has been done on this subject, and it is only within the last two decades that chemists have discovered why soap solutions have what is called a "detergent" action. When this point had been reached, the most obvious step was to attempt to synthesize substances having soap-like properties, but with none of their corresponding disadvantages. Chemists were successful in achieving this object, and the new synthetic detergents are already common in the laundry and textile industries, though their rather higher price does not allow them to compete much with soap for domestic purposes.

A pure sodium soap consists of a mixture of the sodium salts of various related fatty acids, such as stearic, palmitic or oleic acids. For practical purposes soap may be considered as sodium stearate ($C_{17}H_{35}.COONa$). Dilute solutions of this material exhibit properties which account for its use as a detergent. The most noticeable property is that soap solutions have a very much lower surface tension than water. In ordinary language this means that they can wet surfaces, particularly greasy surfaces, very easily. This property also makes the removal of grease from surfaces easier, since grease surrounded by soap solution has a tendency to form into globules which are easily removed by agitation. It is also this property of having a low surface tension that causes soap solutions to lather.

Colloidal Solutions

Another distinctive property of soap is that it forms what are called colloidal solutions—that is, solutions in which the actual molecules of soap remain in aggregates in the solution, and are not completely separated as is the case with a solution of, say, common salt. It is a property of colloidal solutions that they have the power of adsorbing other particles of matter, and it is suggested that the groups of soap molecules in a soap solution adsorb small particles of dirt. This is partly confirmed by the fact that other colloidal solutions, such as glue and gelatine, have some detergent properties, though none are as effective as soap.

Emulsifying Agents

Perhaps the most important property of soap however, is that it is an excellent emulsifying agent. This means that it has the power of preserving minute drops of oil or grease in suspension in water indefinitely. Normally, a mixture of oil and water will separate into two layers in a short time however vigorously the mixture is shaken. But if a little soap is added the mixture will form into a milky fluid which is actually a suspension of very fine drops of oil in water. This is an emulsion, and however long it is kept, there should be no separation of the oil and water. The value of this property in washing is that once oil and grease have been removed from clothes they must be emulsified immediately, or they will settle back on to the clothes. The presence of an emulsifying agent will prevent this, and soap is probably the most effective agent known.

Another less important property of soap is that it is alkaline in solution, and since much of the dirt on clothes is acidic in nature owing to perspiration, this alkalinity materially assists its removal. Washing dirty fabrics is therefore a series of distinct processes. First the soap solution wets the

surface of the fabric and penetrates into the small interstices between the fibres. Acidic soiling matter is then neutralized and partly removed, and greasy matter is made to coalesce into little balls which are removed by agitation. This also brings away a lot of the solid dirt also. Finally the soap solution emulsifies the grease and soiling matter, leaving them suspended in the water in such a manner that they cannot fall back on to the clean fabric.

Despite its convenient combination of properties, soap has certain disadvantages. The most important is that it will not lather in hard water. Hard water contains calcium salts which in contact with soap (sodium stearate) react to form calcium stearate or "Lime Soap". This substance is insoluble. and has no detergent properties. The scum often found after washing in hard water is chiefly lime soap. A disadvantage of minor importance is that soap cannot be used in acid solution since it decomposes to give the original fat from which it was made. This is of importance only in the dyeing industry where dyeings are frequently done in acid solution, and where the presence of soap would help to give a level result.

Soap Substitutes

It was to overcome these difficulties that research was started with the object of finding a substitute for soap. The action of sulphuric acid on castor oil to give the familiar Turkey red oil had been known for some time, and Turkey red oil was known to be a fair detergent which was much less affected by hard water than was soap. It was on these lines therefore that experiments were directed. By introducing sulphate and sulphonate groups into the molecules of fatty compounds, soap-like materials were obtained, and some of them proved to be excellent detergents, while their stability to hard water was considerably improved because their calcium salts were soluble. Thus by modifying the soap molecule, chemists produced a compound which had all the advantages of soap, but none of its disadvantages.

These products of course have similar structures to the ordinary soaps in that they are the sodium salts of fatty compounds. But other new detergents were found—some of them quite unrelated to the ordinary soaps. The result of introducing a sulphonate group into the naphthalene molecule gave a substance with soap-like properties—a discovery which was of considerable importance in Germany during the war, when the supply of fats was short. Further research resulted in the production of detergents some of which were not even sodium salts, and there are now many synthetic detergents all with special properties of their own, and most of them unrelated to the ordinary soaps in their chemical structure. Many of these new compounds are completely stable in hard water, and can be used in acid or alkaline solution, and their detergent power is equal to, and frequently greater than that of soap. As a rule they are more soluble than the soaps and this enables washing to be done in cold water, whereas most ordinary soaps are not very soluble in cold water. But because of the expense of treating the raw materials before manufacturing the detergents, they are as a rule more expensive than soaps, and except in special circumstances they cannot compete with it. At present their use is confined to the textile and laundry industries for special purposes, and in cosmetics. Almost all face creams, salves, shaving creams, etc. contain soaps and the newer detergents can usually replace soap with advantage.

So far the public is scarcely aware that a new type of detergent is beginning to challenge soap, but in time the new products will compete with soap on fair terms, and it will be interesting to see if scientific research is successful in ousting a product which has been used for 2000 years. T.K.

By E. A. CRUTCHLEY

PRINTING can be described most simply as "the repetition of an image by the transference of ink from a prepared surface to a receptive material". It first existed in the blocking of patterns on cloth. Then somebody thought of cutting inverted letters in blocks of wood, so that inked impressions could be made on paper or skin, giving an effect which was very similar to a manuscript written by a scribe.

Laborious as scribing must have been, this new process was little better, but in the middle of the fifteenth century a German called Gutenburg hit on the idea of movable types. Once a fount of letters had been designed and cut in metal, it was simply a matter of arranging single pieces of type in words and pages, printing the required number of copies, then distributing the type and rearranging it for further pages—a very much quicker task than carving each page separately in wood.

The principle on which Gutenburg worked is precisely the same as that used most commonly to-day. In Fig. 1, reproduced from an old engraving, you see, on

Fig. 1. *Early printers at work*

the left, compositors setting up type from their "cases". On the right are two pressmen, the far one inking his type with a sort of padded pestle, the nearer one applying paper to the type under heavy pressure. The boy in the foreground is piling up the printed sheets, which have been dried by hanging from the clothes-lines on the right of the picture.

To-day type is mostly set mechanically, and presses are differently constructed and power-driven. But the principle is the same—the arrangement of type in words and lines and pages, the application of ink, and the transference of the image by pressure on to paper.

Composing machines produce type either in single letters or in complete lines, and it is by the former process, most often used for books, that *Discovery* is set. The two separate machines of the "Monotype" system, the keyboard and caster, are shown in Figs. 3 and 4. The metal used for type is made up of roughly 80 % lead, which forms the body of the alloy, 10 % tin to give it fluidity and toughness, and 10 % antimony for hardness and for expansion at the moment of casting. The standard height of each piece of type is just under an inch, or (as you see in Fig. 2) about the diameter of a shilling.

Thus, letter by letter, the type is made up into lines, and, line by line, the tray (or

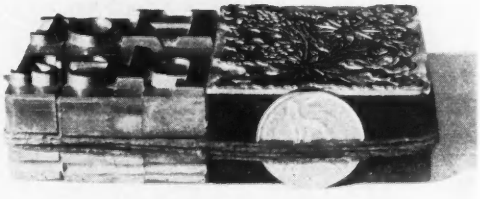

Fig. 3. The Monotype keyboard is operated like a typewriter, but with extra keys for small capitals, italics, and so on. As each key is struck a pair of holes is punched in the revolving roll of paper seen at the top of the picture. At the end of every line the rotating drum in the middle tells the operator what spacing is necessary between the words in order to fill out the line to the right

"galley") is filled. The next operation is to divide it up into pages of uniform length and arrange these into units, usually of eight or sixteen, each page surrounded by margins of wooden or metal strips. The whole is locked into a steel frame by the insertion of wedges, so that the "formes" can be lifted and carried to the press without danger of the type falling out.

This forme is next laid on the bed of a

Fig. 4. The perforated roll is transferred to the caster and mechanically unrolled. As each pair of holes passes over a certain point, compressed air escapes through them, regulating the movement of a matrix-case and bringing the required letter into position. A jet of molten metal is shot up into it through a mould, drops and cools, and is a piece of type

press which, after the necessary preparation, is set in motion. The bed slides back and forth, first under rollers which cover the type with ink, then under a revolving cylinder synchronized with the movement of the bed. A sheet of paper is carried by the cylinder, receives an impression as the type slides under (see Fig. 7), and is passed on to a delivery board where it is automatically piled, sheet by sheet, until

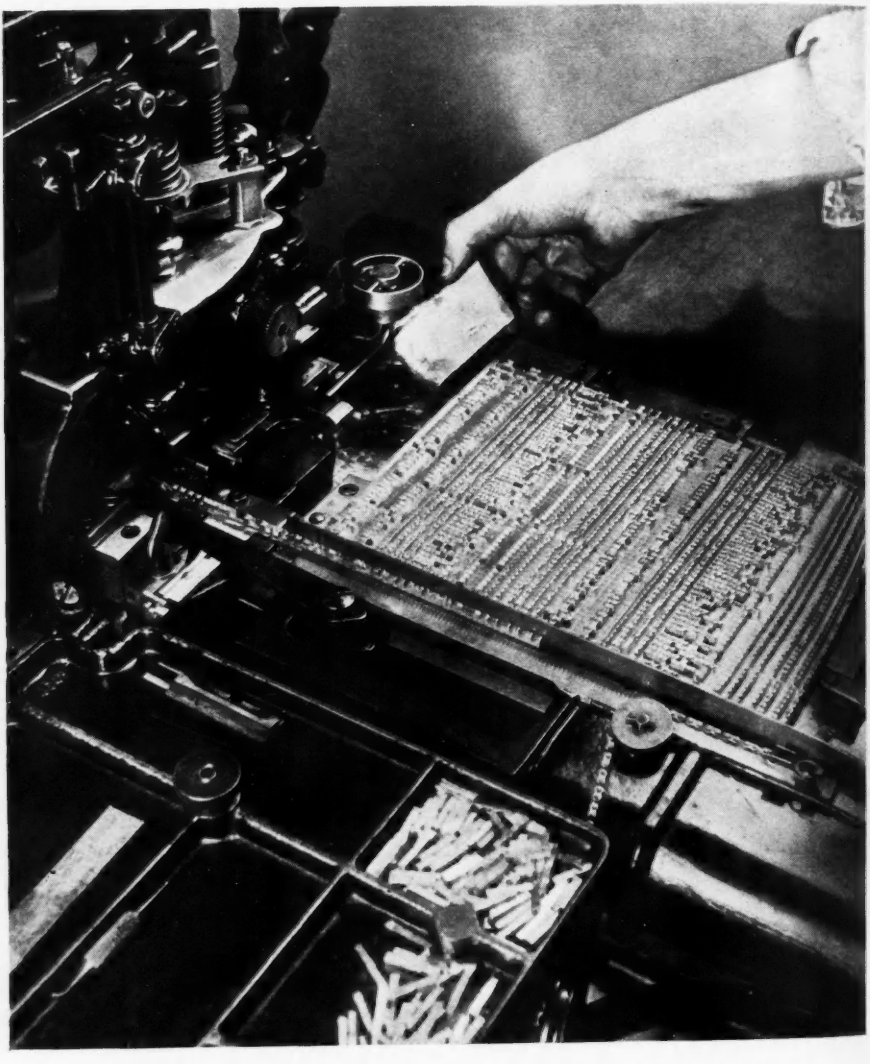

Fig. 5. Close-up of the Monotype caster; a metal ingot is being dropped into the melting-pot

the required number of copies is printed. Another forme is then substituted, and so on until the whole book is printed.

All illustrations are printed from "blocks", either engraved in wood by hand or mechanically etched in metal and mounted to the same height as the type, as shown in Fig. 2. There are two kinds of illustration, best exemplified by pen drawings on the one hand and photo-

graphs on the other. The first variety deals in simple lines and dots and sometimes larger solids. There is black and white and nothing in between, except in so far as greys can be represented by setting black and white close together. Such subjects are normally engraved mechanically. The original is first photographed to the size required for the reproduction. The negative is printed on to a zinc plate coated with a thin film of sensitized albumen, which is then covered with a layer of ink. Where light has passed through the negative, that is, in the black parts of the picture, the albumen is fixed. Where light has been obstructed the albumen can be washed away with water, and the ink with it.

The zinc plate is next dipped in a succession of nitric acid baths, where the unprotected parts are etched away. We are left with a reproduction of the original image standing in relief, reversed of course, so that it bears the same relation to the picture printed from it as a photographic negative does to a positive.

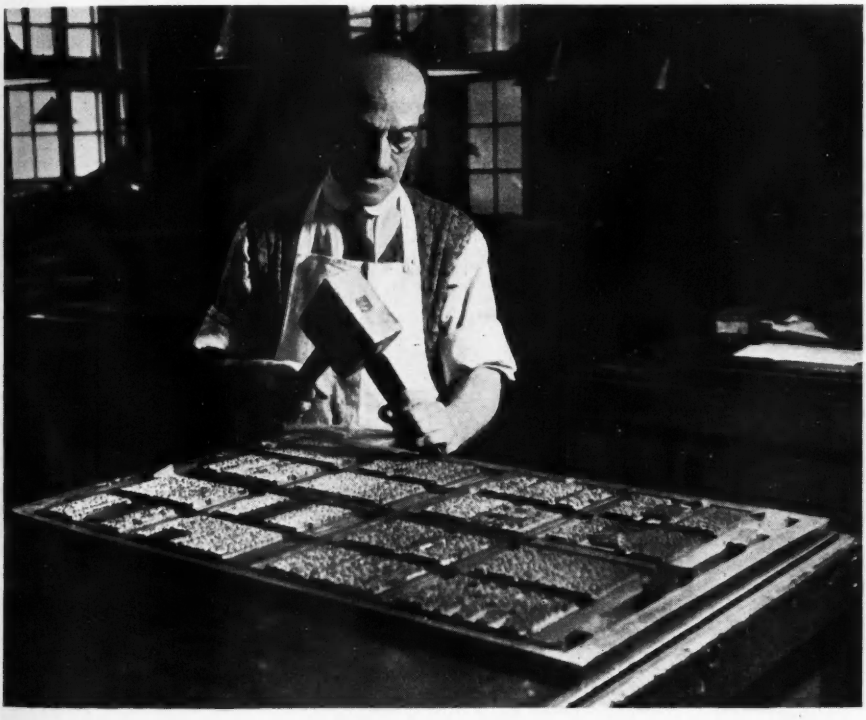

Fig. 6. Locking up a sixteen-page forme

The second kind of illustration, used to reproduce fine gradations of tone such as we find in photographs or paintings, is carried out by an optical illusion, the whole subject being broken up into minute dots whose size varies according to the tone. Where the original is solid black, the dots are large; where it is light, they are small. If you look through a magnifying glass at one of the photographs reproduced

in this article—or better still in a newspaper, where the coarseness of the paper demands widely-spaced dots—you will see them quite distinctly.

The process used for making these "half-tone" blocks is much the same as that used for simple line blocks, except for the additional operation of breaking up the continuous tones of the original into dots. This is done by photographing through a glass screen, ruled horizontally and vertically. The action of the "penumbral shadow", which causes round dots instead of square ones, is a scientific mystery which does not greatly affect the printed result.

The reproduction of colours is carried out by making up a separate forme for each one and printing them in turn. In the case of a painting or coloured photograph, the original has to be broken up into the primaries and a separate block made for each one. The fact that all colours can be reduced to constituents of yellow, red and blue was discovered by Clerk Maxwell in the middle of the last century, and its application has considerably reduced the cost of colour printing.

The block-engraver detects the presence and strength of each colour by the use of filters, and a simple experiment will show you how these work. If you take a piece of green glass and look through it at a bright red and green object, such as a red flower with green leaves, the leaves

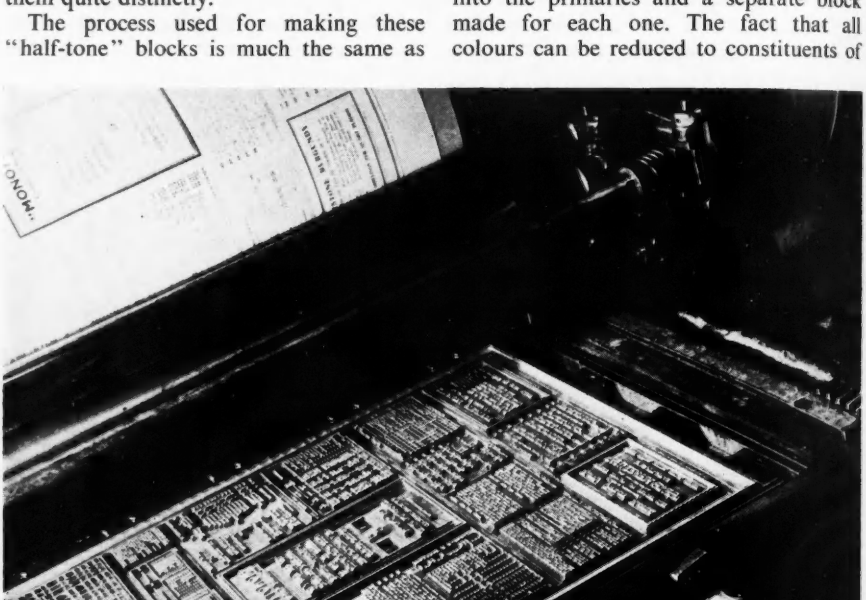

Fig. 7. Type and paper, the moment after contact

will appear very light and the flower quite black. An ordinary photograph taken through a green glass will show black flowers and light grey leaves. If we make a block from this photograph and print it with red ink, we get red flowers and only a small trace of red on the leaves. In this way, by the use of three separate filters, each primary colour is detected in turn and the blocks are engraved for printing in succession in coloured inks.

We have dealt so far with that form of printing where the image is raised in relief. It is also possible to print from a surface in which the image is not raised, but sunk. This process is known as intaglio or gravure, and the methods of preparing the plates and printing from them are somewhat different. Single types are not used, and if letterpress is to be reproduced it is necessary to set it up first by the relief process and take a print which is photographed and etched on to a plate in much the same way as relief blocks are made, an acid-resist protecting the necessary parts. There is no screen, but the plate has a fine grain so that the etched parts will hold the ink.

The plate is inked, then wiped, so that there is no ink left on the surface but only in the incised parts. Paper is applied under pressure, draws up the ink, and so receives the image. Until recent years this process was only used for copper-plate engravings and mezzotints, but it has now been developed and is regularly used for many magazines.

Still another process, which is also being used more and more, is surface printing, best known in lithography. The technique here is different again, as the image is neither cut in relief nor incised, but is laid on the surface of a piece of stone, or, more frequently nowadays, on a metal sheet, in a substance such as beeswax which will resist water. The plate is then damped, and afterwards inked. Where the water remains, the ink will not take; where there is no water, that is, on the image itself, the ink stays and is transferred to paper in the usual way. Some magazines and books are printed by this method, and most of the posters you see on hoardings. Each printing technique has its own advantages and is particularly suitable to certain kinds of work.

The various processes of engraving and printing entail scores of delicate operations, but of these the reading man or woman is normally unaware. All they see is paper and ink. Ink consists of a pigment in a varnish medium, and it dries in one or two or all of three ways—by absorption into the paper, by oxidization on the surface, and by evaporation. The pigment most often used is a carbon black produced from the incomplete combustion of natural gas.

Papers are most commonly made from rag, esparto grass, or wood, though other fibrous materials such as bamboo are occasionally used. The raw product is pulped and bleached; then it goes through a process of beating which reduces it to a fluid state. In the next stage the fibres are gently shaken together again along a continuous web and all the water content is drawn off. To obtain a smooth surface the paper is finally passed through a succession of hot rollers, or, in the case of writing papers, dipped in tanks of gelatine. Sometimes china clay is added to give the highly glazed surface required for the printing of fine half-tone blocks.

A scientific laboratory is maintained in London by the printing and allied trades, where a band of chemists and physicists researches into materials and processes, and investigates the day-to-day problems which all printers meet in their work.

Reviews

Popular Microbiology

IN these columns a few months ago I praised R. Goldschmidt's "*Ascaris*": *The Biologist's Story of Life*. Now, again I am able to tell the readers of *Discovery* of a book* of similar merits issued by the same publishers. Professor Bigger, of Trinity College, Dublin, has written a popular account of Bacteriology. The holder of a chair for Bacteriology and Preventive Medicine—who himself only a short time ago made a most valuable contribution to public health by his research on certain pathogen bacteria in milk—has given a survey of his field which will be read and enjoyed alike by schoolboys and professors of bacteriology. He writes: "I do not believe that the aims and achievements of science should be veiled from all but a special class of persons. Scientists, in their text-books and journals, employ a highly technical jargon, almost unintelligible to a layman, but they should be able, when called upon to do so, to translate this jargon into ordinary English. . . . Every animal, from the great reptiles which roamed the earth in the distant Jurassic period to the civilized man of to-day, has engaged in a twofold struggle for existence—the obvious one against competitors of his own and other species, and the infinitely more important one against microbes." Professor Bigger's book deals mainly with the struggle of the last fifty years in which man, "first ignorant of the existence of microbes, then merely an observer of them, has acquired a control of microbes which will ultimately give him mastery".

(*Illustration by permission of John Bayle*)

Antony van Leeuwenhoek, 1632–1723

The book has three parts, and a prologue which introduces the first microbiologist, Antony von Leeuwenhoek, a Dutchman (1632–1723), who made microscopy a hobby, and who was draper and haberdasher, surveyor, wine-gauger and "Chamberlain of the Council Chamber of the worshipful Sheriffs of Delft". One part, helped by graphs and photographs, discusses the aims of microbiology. The author explains what microbes are and what the difference is between bacteria, viruses and Protozoa. The equipment of a modern bacteriological laboratory is pictured. Professor Bigger then deals with the many methods of identifying certain species and the knowledge we have of bacterial metabolisms. These chapters are especially delightful for their clarity, and in them the author admirably

* *Man against Microbe*, by J. W. Bigger. Eng. Univ. Press. 7*s*. 6*d*.

endeavours to make difficult problems intelligible, at the same time maintaining scientific exactness to the last. In the last pages of this first part, the author gives an account of the ways of infection, and of immunity.

The second section of the book is devoted to the history of microbiology, and the third to more general problems such as social hygiene. A helpful glossary and index conclude the volume.

The historical aspect of microbiology is put in the foreground throughout the book. Famous scientists are described and their portraits inserted, yet the author avoids the common error of transforming the history of microbiology into a chain of biographies.

H. LEHMANN

Science Competition

Questions on the contents of the book reviewed above are set by the author, and form a competition for schools arranged by the publishers, The English Universities Press, Little Paul's House, Warwick Square, E.C. 4, *from whom further details and conditions of entry can be obtained.*

The Doyen of British Philosophers

Now that we have lost in Samuel Alexander the one philosopher in the country who had been distinguished by the O.M., Professor Whitehead stands out in greater and more solitary splendour than before. It is true that he speaks to us across the Atlantic, but for that we should perhaps be still more thankful, for he has a far wider audience to address in the U.S.A. than he would in these islands. His last book* consists of six lectures delivered in Wellesley College, Mass., and two in the University of Chicago. They form a small volume and have the special interest of summing up much that he has said in earlier works. It is impossible in so short a space to give even the substance of what he says, but it will be, and certainly should be, widely studied. One or two points stand out to which the shortest notice should draw attention. The first is that in which he agrees with the late Professor Alexander. Both of them are concerned with the religious aspect—that is the consideration of worth or ideal—as affected with the marked advance of science in their own and in recent times. It will be enough in this connexion to refer to the title of Alexander's chief work which is mentioned with praise by Dr Whitehead. "Space, Time and Deity" was the famous title under which Alexander wrote. It implied clearly the new conception of a Space-Time continuum while pointing to the higher state of being which mankind is constantly striving to attain. "Deity" was a new use of the time-honoured word under which the philosopher described that state of being towards which mankind and the universe are always tending, and we shall find with ease the analogue to this conception in Professor Whitehead's volume. Both philosophers were also men of science, Whitehead being one of the leading mathematicians now living. Our greatest difficulty with him is his invincible turn for new expressions. In some of his earlier books the use of the term "organism" was calculated to confound the older school of biologists who saw in it only the expression of the operation of a "vitality" denied to the major part of the created world. This is fully met in the explanations afforded in the new volume. But he again indulges his taste for new forms of expression. Thus we are told that "importance" and "matter of fact" are the two contrasted notions which underlie all width of experience. No one, we incline to think, would feel it necessary to deny the statements, though they are hardly in themselves calculated to spread much further light on the subject. The light, however, comes when we follow Professor Whitehead in his examination of the eternal process which is going on in the world and of which we are, as the highest organisms or known concretions, the concentrated light. Shortly put, the whole spatial universe is a field of force, and at the basis of our existence is the sense of worth. The progress of man's thought has done away with the static conceptions of space and form which were inherited from the Greeks and received their most complete representation in the Newtonian system. Now we have attained a conception of internal relations throughout the universe, all in a complex state of activity. In this sense all is organic, and the various grades of organic activity are distinguished by the degree to which they attain the conception of a purpose. Man is the highest, because in him has been reached the idea of a future, and he alone, so far as we know, has the conscious purpose of creating one.

It is a book full of wise and pregnant sayings, just and appreciative to predecessors, above all inspiring to fresh thought, purpose and unity in the universe of to-morrow.

F. S. MARVIN

* *Modes of Thought*, by Alfred North Whitehead. Cambridge University Press. 7*s.* 6*d.*

Tools and the Man

During the past ten or twelve years a change has come about in the study of the civilizations of the Stone Age, and more especially the Old Stone Age, which is revolutionary. Up till then France, with the whole of

north-western Europe in its train, held the centre of the stage in palaeolithic studies. Both chronologically and typologically knowledge of the cultures and industries of early man was determined by reference to the classical division of the early periods of man's cultural development as formulated first by de Mortillet and afterwards further elaborated by Breuil—the familiar sequence of Chellean, Acheulean, Mousterian, Aurignacian, Solutrean and Magdalenian. Of these the two first were industries in which the implements were cores, i.e. had been fashioned by flakes being struck from them, while later, from Mousterian onward, the flake struck from the core became the implement. By recent discovery this long-accepted and ordered system is in process of being transformed.

The existence of Stone Age man outside Europe has, of course, long been known; but it is only in these recent years, with the amplification of study of the extra-European Stone Age cultures—in Palestine and western Asia, in Egypt and in North, East, and South Africa, to name the most important, that it has become patent that the classical succession of the palaeolithic period in France is a local development, which must be fitted into a world-wide system, rather than imposed upon it as the chronological and typological standard.

Further, it has become no less evident from study of the world-wide distribution of types that the chronological succession of core and flake implement of the earlier classification does not in fact hold good; but that of the two types each has its separate and distinct province. The flake instrument belongs in relation to the west, to the north and east, the core implement to the south. Only in north-west Europe do the two overlap—not indeed in sequence, but in a broad sense synchronizing in accordance with a somewhat complicated scheme of relationship, which is made apparent in the analysis of the terrace deposits of the Somme valley during the Ice Age, as recently worked out by the Abbé Breuil.

In view of these developments it is inevitable that current text-books should stand in need of remodelling, although, as Mr Wright points out in his *Tools and the Man*,* the hitherto accepted classification is too deeply engrained in archaeological studies to be abandoned forthwith and completely. He himself in this study of Stone Age prehistory has made the tradition his starting point; but passing from it he reviews the development of man's early civilization from the revised point of view indicated above in the light of the most recent contributions of geology, palaeontology, palaeobotany and climatology. In much of what he has to say his point of view is individual and will provoke discussion among his colleagues and fellow-workers. Nevertheless in his skilful handling of a number of topics of extreme intricacy he has done yeoman service to the cause of archaeological science.

E. N. FALLAIZE

* *Tools and the Man*, by W. B. Wright. Bell. 12*s*. 6*d*.

Life in the Desert

THE average Englishman conceives a desert as a lifeless, waterless waste under a torrid temperature. While this is true of one type, there are several other forms and degrees of desert, and in this interesting introduction to their study* the author, who is Professor of Zoology at San José State College, California, gives descriptions of every type to which the designation may be applied. That is, deserts both temporary and permanent, deserts of "the rain shadows", of "winter cold" and "summer dry", of the lakes and oceans' dunes, of the salt, of the wet, and all-the-year-round deserts. Thus he is on the generous side, stretching the use of the term beyond its every-day meaning. This is to the good, for it is provocative of thought, the chief function of any book.

The author describes in simple language the causes producing deserts and the dodges to which both animals and plants have recourse to provide the water their bodies need. Those who come fresh to the subject will be surprised at the wealth of life which ekes out existence under conditions that at first glance seem impossible. Those already acquainted with the deserts of Africa and Asia will see how like conditions produce like results, and parallel development in disconnected regions.

Outstanding are the sixty-four illustrations of life and scenery in the deserts of Mohave and Colorado in the south-western portions of the United States. Some are striking, in particular the beautiful frontispiece in colour, showing the queerest types of vegetation, from the Joshua Tree to the Squaws' Cabbage. But this well-deserved praise must be qualified, as some have come out so dark that the detail is obscured.

The book would have had greater interest still if the author had touched upon the kindred formation of steppe, and upon the human aspect in his own deserts. There is allusion to the desiccated banks of old lakes, but not to the middens of Indians there dating from the sixteenth century. Nor to the desert trails by which the Mohaves traded with the Pueblos. Nor is there a comparison with the deserts of the Old World. Why have the Amerindians never domesticated wild animals? If America has not the wild horse nor camel, she has at least the goat, sheep, deer and bison. Why did

* *Deserts*, by Gayle Pickwell. McGraw-Hill. 15*s*. net.

the Amerindian remain a savage compared with the Tartar? When the first European (the Spanish missionary Garces) crossed the Mohave in 1776, all the humanity he found there was a remnant of Chemehuevi Indians eking out a miserable existence in the gradually drying-up country. How different from the ancient civilization of Mongolia!

But this is carping. The author has given us a very attractive introduction to the study of desert conditions, which even in our green islands may begin in the sand dunes and salt estuaries of our coasts. M. B.

Select List of Books received by *Discovery*

(*Mention in this list does not preclude review*)

The Quintessence of Bernard Shaw. HENRY CHARLES DUFFIN. (George Allen and Unwin, 7*s*. 6*d*.)

Great Engineers. Professor C. MATCHLOSS, translated by Dr H. STAFFORD HATFIELD. (Bell, 12*s*. 6*d*.)

What Engineers Do (revised edition). WALTER D. BINGER. (Faber and Faber, 7*s*. 6*d*.)

The Railway. EDGAR B. SCHIELDROP. (Hutchinson, 5*s*.)

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Weather in the Making. DOROTHY FISK. (Faber and Faber, 8*s*. 6*d*.)

Experimental Methods in Gas Reactions. A. FARKAS and H. W. MELVILLE. (Macmillan, 30*s*.)

Theoretical Electrochemistry. N. A. MCKENNA. (Macmillan, 15*s*.)

Qualitative Organic Chemistry. NEIL CAMPBELL. (Macmillan, 8*s*. 6*d*.)

A Dictionary of Scientific Terms. I. F. and W. D. HENDERSON. (3rd edition revised by J. H. KENNETH.) (Oliver and Boyd, 16*s*.)

Patterns of Survival. An Anatomy of Life. JOHN HODGSON BRADLEY. (Routledge, 7*s*. 6*d*.)

An Introduction to Modern Genetics. C. H. WADDINGTON. (George Allen and Unwin, 18*s*.)

The World of Man. Book II. *Man and the Earth*. C. C. CARTER and E. C. MARCHANT. (Christophers, 3*s*.)

The Nile Basin. Vol. V. *The Hydrology of the Lake Plateau and Bahr El Jebel*. H. E. HURST and P. PHILIPS. (Schindler's Press, Cairo, 20*s*.)

Sheba's Daughters. H. ST J. B. PHILBY. (Methuen, 21*s*.)

Deserts. GAYLE PICKWELL. (Whittesley House, McGraw-Hill and Co., 15*s*.)

Prehistoric Life. PERCY E. RAYMOND. (Harvard University Press, 21*s*.)

The Native Races of Australasia. Sir JAMES GEORGE FRAZER. (Percy Lund Humphries, 35*s*.)

The Earliest Men. J. REID MOIR. (Macmillan, 1*s*.)

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